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THE WITHERING OF THE FAIR FUND.

A very harmonious meeting of the Gas Industry Council was held at the Astor House in this city on Thursday last, and its deliberations were brought off in consonance with the feeling that actuates those who fear they have assembled to watch the flicker that presages death. And so it was; for when the Council adjourned the Fair Fund was at an end, as per the following preamble and resolution, offered by Capt. W. Henry White, received the assent of all those who were present:

WHEREAS, In view of the fact that, after persistent and continued effort on the part of this Council to secure funds for the purpose of having a special gas exhibit at the World's Columbian Exhibition, to be held in the city of Chicago, in the year 1893, but $66,580.28 has been subscribed by the Gas Companies and allied interests, and there being no prospect that this amount can be sufficiently increased to warrant this Council in continuing its efforts to secure such an exhibition; be it, therefore,

Resolved, That the Gas Industry Council returns thanks to the several subscribing companies and manufacturers and does adjourn *sine die*.

Under our current knowledge of the failure of the Fund we are not disposed to say much respecting the causes that led to this unfortunate termination, other than to give expression to sincere regret that the Council could not see its way clear towards accepting the conditions as these existed—that is to say, that the Council was unwilling to proceed with the project on a scale smaller than the one originally proposed. Subscriptions to the amount of $66,580.28 (the Fund stood at those figures on the evening of July 27th, and was not augmented any in the week ended the evening of August 3d) had been pledged, and we submit that this sum would have been sufficient to have maintained an exhibition of gas and gas appliances at the Fair that would not have been discreditable to the industry. While not knowing that such was actually the case, it appears to us that many of the subscriptions made must have been offered in a tentative way; or, to put it plainer, were conditional. So, if a goodly percentage of the Fund was only available in case a certain maximum sum was raised, the Council had little recourse than to face the inevitable, resign its trust, and say to the fraternity, we accept your verdict. The humiliation, and such it is, is complete, and those whose solidity have contributed to the result ought to feel gratified. To complete their barren victory—for we fail to see where they are to be benefited—they have only now to say, "We told you how it would be!" and no doubt their voices will be so raised. In the meantime, those who have, in the Council and out of it, worked faithfully and with good will for the securing of the ultimate object of the proposed Fund—which was nothing more or less than a desire to aid and benefit the gas industry at large—have nothing to reproach themselves with. The members of the original committees of the various Associations, the Gas Industry Council, many of our readers and the JOURNAL have all worked in harmonious accord, without any other purpose than a genuine desire to see gas shown at its best estate before the eyes of the hundreds of thousands who will visit the Fair in '93. Those who urged the project have given freely of their time and thought, and their only cause for regret is, not that such time and thought were expended, but rather that the outcome proves that the gas makers of the country are very largely—what shall

we say? Well, that they are largely conservative. There can be no doubt about it that the failure to raise the Fund will ultimately exert its effect on the pockets of those conservatives; but if it stopped there no one would have much cause for sorrow. The real trouble is that the pockets of the liberal will also be affected. We make no doubt that the failure to have separate representation of the gas industry at the World's Fair will to some extent unfavorably affect gas investments, and that depression will unfortunately come with greatest force upon the holders of shares in the list of companies of the smaller order.

BRIEFLY TOLD.

THE RESTORATION OF THOSE OVERCOME BY INHALING ILLUMINATING GAS.—"W. A.," writing to the JOURNAL under date of August 2d, says: "I wish to make a few remarks on Mr. Gerhard's suggestion * for the treatment of persons overcome by the inhalation of illuminating gas. I have seen hundreds of men overcome by the inhalation of gas, and I wish to say that to keep a man so overcome on his back would be the worst possible course to pursue; and I should expect to see a man so placed succumb rather than revive under that treatment. The absence of air in the lungs must of necessity cause the limbs to become damp and cold. If the following instructions be faithfully followed—I do not care how bad the case may be—I will guarantee that 99 per cent. will be restored, inside half an hour. As soon as it is observed that a man is overcome with gas he should be placed on his feet, and large quantities of milk be given to him to drink. He may show a disinclination to swallow; if so, the milk must be forced down his throat. A man should be placed on each side of the sufferer, and he should then be walked up and down. He will want to sit down, but on no consideration should this be allowed. When the patient vomits, more milk must be administered, and when the patient is out of immediate danger, which will be the case inside of half an hour, he should be placed in bed, when a little warm brandy and water may be given. The above is a panacea, and I confidently submit the recipe to anyone that is engaged on main or service laying. I am aware that all this is diametrically opposed to Mr. Gerhard's theory, but I have proved the efficacy of what I submit to your readers."

MAYOR POTTER VETOES THE PROVIDENCE (R. I.) AGREEMENT.—In our issue for July 18th (p. 84) we gave the text of the agreement entered into between the city of Providence (in so far as the legislative branch of the city was concerned) and the Providence Gas Company, respecting the conditions under which the gas supply of that city was to be carried on for a period of 20 years. Briefly, the city agreed to give the Company the exclusive right to supply gas for the next 20 years, provided the Company, as a first obligation, paid into the city treasury 3 per cent. per annum of its *gross* earnings, and as a second obligation, after it had paid 8 per cent. per annum to its shareholders, and had set apart a sum per annum equal to the amount necessary to keep its works in a condition to respond to all demands that might be made upon them, to apply any surplus in the direction of reducing the gas rate. These provisions seemed to be so fair that the Counsel assented to the same and the agreement came before the Mayor for his approval. While it was known that Mayor Potter was somewat of a politician, it was nevertheless believed that his demagogic principles or beliefs would not blind him in respect to an agreement that, while it would work fairly in respect of capitalist's rights, would also inure to the benefit of the city and its citizens. The Mayor, however, was not superior to demagogism, and in proof thereof he has vetoed that which, in our belief, would be of greater benefit to the people of Providence than it would have been to the Providence Gas Company.

NOTES.—We regret to record the death of Colonel John A. Price, of Scranton, Pa., on the evening of August 3d. Colonel Price, who was in his 50th year, was President of the National Board of Trade and a member of the State (Pa.) Commission for the Equalization of Taxes. Deceased was a graduate of Brown University, was prominently identified with the coal interests of Pennsylvania, was closely connected with many business enterprises in Scranton, and was an occasional contributor to our columns.——The gas plant of the Montgomery (Ala.) Light Company is being virtually rebuilt. The expenditure will amount to $40,000.——Nashville, Tenn., has appointed a committee to report upon the cost of installing an electric lighting plant, to be operated on municipal account.——Henry B. Stratton has been appointed a clerk to the Bureau of Gas, Philadelphia, vice Jno. R. Forman, resigned.

* Ante, p. 111.

The Distribution of Fuel and Power Gas in Birmingham (England.)

[Communicated by Mr. B. H. Thwaite, F.C.S., to the *Journal of Gas Lighting*.]

It is now some ninety years ago since the illustrious Willie Murdoch startled his Birmingham townsmen by a display of gas lighting at the famous Soho Works of Boulton & Watt; and in ten years hence the centennary of the introduction of this great invention will have to be celebrated. Since the date of the introduction of gas lighting in 1802, there is probably no town with any pretence to civilization unequipped with plant for the manufacture of lighting gas, based on the system introduced by the ingenious Murdoch; and it may be computed that the total expenditure on gas plant reaches several hundred millions sterling. In Great Britain alone, the amount will not be over-estimated at fifty millions sterling. There is no doubt but that the introduction of this handy and convenient illuminant has effected more good for the people morally and socially than all the Acts of Parliament from the time of Edward the First.

It is rather coincidental that Birmingham, occupying a premier position as a progressive municipality—a town which is at once the envy and the emulation of other corporations—should have been the geographic site of the initiation of gas lighting. It would, therefore, be magnificently appropriate if this famous town should initiate in Europe at least, the general use, under corporate direction, of the only scientific, hygienic, and economical method by which our great natural fuel resources may be consumed for domestic and industrial purposes.

In the increasingly difficult struggle for commercial supremacy, the natural advantages of one town or country over those of another will inevitably decide the future victory; and no natural resource is more valuable than that which contributes power and heat. The lavishness with which Nature has endowed the British manufacturer has not met the appreciative return that should have been given, and the flagrant waste of fuel is evident on all hands; so that, if, almost in disgust with such extravagance, Nature has deposited the sooty particles of imperfect and wasteful combustion on the architectural creations of men, and has inflicted periods of fogs as black as the blackest night (carrying in their train death, disease, and misery), such evidences of Nature's displeasure and revolt should not be lost upon us. If we have the advantage of natural fuel resources over our foreign competitors, the nature of such advantages is neutralized if we utilize our fuel wastefully, and the foreigner utilizes his fuel economically.

Wherever fuel or power is cheap, there man proceeds to erect his manufactories—formerly the corn mill by the stream, or the windmill on the hill. Pittsburg, Penn., thanks to its natural gas and other fuel resources, is the center of a great manufacturing area; and here Nature has shown to the eyes of men the condition into which fuel should be converted before its use in manufactories and on our own domestic hearths. Here fuel gas issues at high pressure from subterranean storage strata, and is distributed for upwards of 70 miles, for almost every purpose requiring heat. The universal use of this fuel has metamorphosed the atmosphere of this remarkable region; and it will be a source of regret if the exhaustion of this natural gas occurs before the plant for artificial fuel gas is erected. The users of this fuel gas are altogether in its favor—given that its financial cost is such as to permit its economic use.

As an instance of the importance of the advantages of natural resources for producing power, one has only to refer to the mountainous districts of Switzerland, where—thanks to the dynamic power stored in the numerous waterfalls, and to the transformation and transmission of such power by the turbine and electro dynamos—new industries are constantly being developed; and to day, in humble and primitive cottages, electric power and light can be found, enabling the fortunate Swiss artizan to compete in new branches of industries with those of Birmingham.

How important and vital, therefore, in the face of such future competition is this question of fuel economy! It is the object of this article to demonstrate that fuel gas is the most economical form in which such economy can be obtained; and in the legacy of distributing mains and air compressors, the Birmingham corporation have an opportunity for initiation in England the transmission of fuel power, which, if carried out, would be a fitting sequel to its historic connection with the application of lighting gas.

Given the absence of any other source of power than carbonaceous fuel, the advantage of transmitting such power by converting the fuel into heating gas and distributing the gas along the mains, can easily be shown to be both real and substantial. The transmission of power over

long distances by compressed air absorbs, in compression and transmission, a considerable amount of energy, varying with the length; but the maximum useful efficiency for one mile will never exceed 50 per cent. The transmission of power by electricity, taking into account the loss in general use, will not exceed in useful efficiency 80 per cent. of the power contributed to the conductor mains; whereas the expenditure in transmitting gas will never exceed $\frac{1}{10}$ of the initial energy supplied with the gas. The cost of power by hydraulic transmission may be taken at 6d. per brake horse power. With gas power transmission all that is required is to move the gas forward at a pressure of 4 inches of water, which is equivalent to 21 lbs. to the foot and is usually quite adequate. To transmit 3,000-horse power of gas, only one indicated horse power of energy is required.

Of course, the same law holds good in transmitting gas as for air or other gaseous mediums; the volume of gas that can be sent through the mains depending upon their diameter and their length—varying directly as the square of the diameter and inversely as the square root of the length. A main 9 inches in diameter, and at a pressure of 4 inches of water, or 21 lbs. to the foot, will deliver through 1 mile length of mains, sufficient gas to develop 1,260 brake horse power; and at a pressure of 45 lbs. to the square foot, the volume will easily be trebled, or be equal to the development of 3,780 brake horse power per hour.

With the slight exception of a loss by the deposition of some of the imperfectly fixed hydrocarbons, there is no loss in the intrinsic thermic value of the gas sent through the mains; whereas, by the transmission of air, there is a loss by thermal convection and radiation. In the transmission of electric energy, there is the loss by bad insulations, and the high resistance of the conductor mains, by which the original energy is somewhat reduced, as already indicated.

The ideal method of transmitting power may be described thus: The intrinsic thermic energy must be distributed from one or more principal central generating stations, and sent through the mains, at pressures corresponding to the requirements, to subsidiary stations, in which the thermic energy is converted into electro-dynamic energy by gas engines and dynamos, and transmitted for purposes of power, light, and other industrial and widely increasing applications of electricity, the domain of which is widening day by day with almost "Arabian Nights" magic. This method would enable the undoubted advantages of electric lighting and electro dynamic application to be obtained in the most economic way; and it would avoid to a considerable extent the use of secondary storage batteries, which add to the cost of electric energy for whatever purpose to a serious degree.

The air compression plant at the central station of the late Birmingham Compressed Air Company is of a high constructive class. It comprises three inverted triple expansion condensing engines. The high pressure cylinder is 20 inches diameter; the intermediate one, 30 inches; and the low pressure one, 48 inches—all 4 feet stroke. The safe piston speed is 400 feet per minute. The fourth engine is of the horizontal type; the high pressure cylinder is 12 inches in diameter; and the low pressure cylinder, 18 inches—with a stroke of 3 feet. The safe piston speed is 360 feet per minute. There are, for the first three engines, in all 18 air compressors of 18 inches in diameter; so that the volume dealt with at atmospheric pressure would be some 13,000 feet per minute.

The air compressors for the fourth engine are two in number, each of 20 inches diameter. At atmospheric pressure the volume dealt with will equal 1,267 cubic feet per minute. If we take only one-half of the total volume, the distributing energy over the whole area—the horse power energy that can be sent through the mains—equals 14,000 brake horse power.

The mains already laid extend through the following streets: Trinity street, Mill lane, Great Barr street, partly through Garrison lane, Gibb street, High street, Green street, partly through Bradford street, Rea street, Burchall street, Thomas street, Henry street, Glover street, New Bond street, part of Coventry road, Floodgate street, Milk street, Oxford street, and partly through Bordesley street.

The distributing mains are most perfectly adapted for the work proposed—they are all lap-welded wrought iron pipes; the connections, valves, etc., being specially cast. The principal main, for about 3,000 feet in length, is 24 inches in internal diameter; and the branch mains are of varying diameters, of 20, 18, 12, 10, and 7 inches. The mains have been laid in special Portland cement concrete, and brick walled trenches. The top of the trenches is covered with concrete slabs, which can be removed for examination purposes. The mains have all been hydraulically tested up to 300 pounds to the square inch. The mains cover an area that will at once adequately test and establish the enormous benefits derivable from the distribution of cheap and convenient power fuel; and then the extensions to the main parts of the town would follow in due course.

Even were the ordinary 17.4-candle gas distributed at a reduction on the price charged for illuminating gas, the benefits that would follow would be exceedingly great; but were the gas supplied of lower photometric or luminous value (say 10 or 12 candles), the popularity of the fuel would far more rapidly spread.

The following comparative estimation demonstrates the thermic advantages of low candle power gas. The comparison of the thermic values has been taken by the evaporation test, as being the only reliable one. A comparison might be drawn between the consumption of gas in different gas engines of a specific power; but unless these tests are made on the same engine, and the proportion of air was the same, and the conditions of the one are identical in every sense, such a comparison would be useless and misleading. It is well known that anthracite and coke gas have no illuminating power; nevertheless, the power developed by such a non luminous gas can, by the adjustment of the air, be made to fairly correspond with that of illuminating gas. The relative pressures established with these gases are as follows:

Gas Engine "Otto" (9 Nominal Horse Power).

Photometric Value.	Character of Gas.	Average Pressure Developed.
17.4 candles	Birmingham gas	70 lbs.
nil	Anthracite	66 lbs.
nil	Coke	62 lbs.

So that we realize that it is not necessary that fuel gas should have in its constitution the luminous producing hydrocarbons to be economically available for gas engines; and the non-luminous and cheap gas can be so dealt with, by a regulation of the air, as to develop, within a fair margin, the same power. The following table shows varying photometric values and the corresponding thermic values; the thermic or heat value of the gas being determined by the cubic feet of gas required to evaporate 10 lbs. of water:

Photometric Value Sperm Candle Power.	Cubic Feet of Gas Consumed.	Relative Greater Percentage Increase of Thermic or Heating Power of Gas in Inverse Ratio to Photometric Value.
10.5	28.00	Unity.
13.5	22.50	5.0 per cent.
14.5	22.00	12.2 "
16.5	21.75	26.0 "
20.0	20.50	44.4 "
22 0	19.75	55.5 "
24.0	18.50	59.0 "

The following table shows the thermic and photometric values of the gas of Manchester and London:

Make of Gas.	Photometric Value in Sperm Candles.	Thermic Value British Thermal Units.	Greater Relative Percentage Increase of Heating Power Ratio, in Comparison with Photometric Value; taking 21-Candle Power and 765 British Thermal Units to be Equal to Unity.
Manchester	21	765	Unity.
London gas*	20	731	0.33 per cent.
"	16	729	25.6 "
"	12	686	57 "
"	12†	732	67.5 "

* Average of a series of tests. † Dr. Frankland.

Sufficient data has been given to demonstrate, *nemine contradicente*, that it is not advisable to give to fuel-power gas a high luminous value; and when it is understood that to raise the ordinary lighting gas up to the photometric statutory requirement an expensive coal of increasing rarity—such as cannel—will be necessary, and that, when this additional ratio of expense required to give the luminous value is added to the ratio in favor of fuel-power gas of low candle power, the advantage in favor of the lower candle power gas is increased. Ordinary English gas coal costing 12s. per ton will give a gas (economically distilled) of 14.75 candles, and above this photometric value, involves in its production the employment of cannel, costing nearly double the value of coal.

The importance of distributing a low candle power gas, approaching the characteristics of the Pennsylvania natural gas, will be demonstrated further on. For converting heat into work, no instrument yet invented equals the most modern developments of the gas engine; and no modern power invention can be said to have had such a record of unbroken, nor such a striking, success. One firm in England alone (and now the names of the makers is legion) has turned out more than 23,000 engines within the last twelve years.

The improved efficiency of the gas motor will be understood by the following statement: The introduction of the first actual practical gas

motor dates back to 1860. This motor consumed no less than 2,500 liters (89 cubic feet) of gas per indicated horse power, and required 33 gallons, or 150 liters, of jacket water. The "Otto" and Langen engine, introduced some years after, reduced the consumption of gas down to 1,850 liters, or 65 cubic feet. A test of the Charon gas motor in 1890 was found to develop 1-horse power with an absorption of 550 liters, or 19.5 cubic feet, of gas. The latest type of "Otto" gas engine will not consume more than 508 liters, or 18 cubic feet.

We will now compare the relative thermo-dynamic efficiency of the different gas motors in their historic sequence. Prefacing this comparison by a definition of comparative data, we will accept 270,000 kilogrammes as representing 1-horse power. Dividing this factor by the mechanical equivalent of heat, or 425, we have the figure 635, which represents the number of calories necessary for the production of one actual horse power. If we take 1,000 liters of gas to have a calorific value when consumed equal to 5,500 calories, the number of liters of gas necessary for the production of 635 calories, or for dynamic energy equal to a horse power, will be equal to

$$\frac{1,000 \times 635}{5,500} = 116 \text{ liters.}$$

We can now readily compare the thermo-dynamic efficiencies of the epoch-marking gas motors:

No. 1.—(1860) $\frac{116}{2,500} \times 100 = 4.6$ per cent.

No. 2.—Otto and Langen $\frac{116}{1,850} \times 100 = 6.2$ per cent.

No. 3.—Otto-Charon (1890) $\frac{116}{550} \times 100 = 21$ per cent.

No. 4.—Otto (British, 1892) $\frac{116}{508} \times 100 = 22.8$ per cent.

We will compare this last statement of efficiency with that of the highest class of steam engine, and the value with the average class of steam engine used by the small manufacturers in Birmingham. It may be accepted that the actual theoretic maximum possible efficiency of the steam engine is 25.6 per cent.; probably the best engines may realize 15 per cent. A careful test of one fairly high-class engine actually gave 11.1 per cent. of the thermo-dynamic efficiency of the fuel used. The ordinary engines in Birmingham will not realize more than 5 per cent. We recognize, therefore, the *prima facie* thermo-dynamic advantages of gas motors, especially of the small type, over that of the steam engine.

Another advantage of the gas engine is its high ratio of actual to indicative efficiency; and it may be stated that the waste of dynamic power by internal work is less with the gas engine than in any other motor. The exact loss of internal expenditure may be taken at 21 per cent. The ratio of brake or actual horse power to indicated horse power equals 78.7 per cent. The thermo-dynamic efficiency is, in this instance, 19 per cent. for the indicative, and 15 per cent. for the actual.

In one recent test the gas consumption was for a brake horse power 693 liters, and the consumption for the indicated horse power equaled 560 liters. The constitution of the gas used was:

Carbonic acid (CO_2)	0.5 per cent.
Carbonic oxide (CO)	4.1 "
Olefines (C_2H_4 and C_4H_8)	5.5 "
Marsh gas (CH_4)	43.4 "
Carbureted hydrogen (CH)	44.1 "
Nitrogen	2.4 "
	100.0 per cent.

The *prima facie* advantage of gas motors over the steam engine, distinctive from the thermo-dynamic one, may be thus summarized. It starts almost immediately, without any tedious and laborious preparation. There is no coal to get in, nor ashes or clinkers to clear away. There is no risk of explosion, nor water gauges or safety valves to watch. There are no fires to slack down, nor safety valves to look after. There is no regular attendance required, beyond oiling, cleaning, and starting.

This appliance has proved to many a struggling small manufacturer a ladder to fortune; and the distribution of fuel-power gas might with advantage be accompanied with an arrangement by the Corporation of hiring out small gas engines, by a charge on the gas. Thus might be made a highly lucrative addition to the revenues of the Corporation. Special artizans might be employed to maintain the gas engines in a condition of efficiency, and train the users, and report on the manner of working of the gas engine. The author is informed that several of the large gas engine makers supply gas engines on the easy payment system. One well-known firm in Manchester have an admirable system of hire-purchase. The terms are one-third cash with engine, and the balance extending over 18 months in equal payments as may be agreed. It would, however, be much more satisfactory if, along with gas cooking stoves, domestic fires, etc., Corporations would supply gas engines up to moderate powers.

M. Aime Witz, of Lille, states that the cheaper gas supplied in Germany has greatly facilitated the popularization and use of gas engines—much more so than in France. The supply of power-gas at not more than an average of 1s. 3d. per 1,000 cubic feet should, along with the hire system proposed, bring gas engines into general use—at all events, in the area of power-gas supply.

The distribution of power gas would make electric lighting almost as economically effected as with gas lighting, because, although *prima facie*, as the author has already pointed out in the *Journal of Gas Lighting*, the electric light in the incandescent form generated from fuel power can never be produced as cheaply as gas lighting, especially if the latter is recuperatively effected, there is no doubt that it will be produced by the system named in some near measure so as to produce the electric incandescent light as cheaply as gas, for a given photometric value. In producing and applying electric energy for lighting, we have the following initial losses—

Gas motors	75 per cent.
Dynamo	10 "
Resistance	5 "
Total	90 per cent.

Or $\frac{9}{10}$ greater initial energy is required than with light from direct combustion. But with incandescent electric lighting there is not so much external energy wasted as in the gas light for a given lighting energy. This can easily be proved by placing the hand near an incandescent lamp of a given voltage, and then near to or over a gas light of equivalent photometric value or candle power. It will be noticed that the loss of radiation and by the thermic waste, as sensible heat, in the products of combustion, is enormously exceeded in the gas light; so that, although there is the initial drawback of 90 per cent. loss of thermo-dynamic energy, and *pari passu* thermo-luminous energy, against the electric light, the efficiency of the electric light at the luminous point is greater than in the gas light, which loses great lighting energy by the waste of heat in radiation and as sensible heat. Actual calorimetric comparative tests confirm this statement. In the best recuperative gas lamps, and in the incandescent gas lamps of the Welsbach type, this loss is, however, very much reduced. The advantage of the fuel gas power in popularizing electric lighting and other applications of electricity will, the author thinks, be now realized. It will, however, be interesting and instructive to compare the thermo-luminous efficiency of gas burnt direct at the gas burner, and also burnt in a modern gas motor; the dynamic energy produced being afterwards converted into luminous energy, thus—

Thermo-dynamic Transformation.	Dynamic Electro-Transformation.	Electro-Luminous Transformation.
Gas motor.	Dynamo.	Incandescent electric light.

For the comparison, a lighting power equivalent to 510 16-candle lights is assumed to be burning for a period of 1 hour. The electric light equipment consists of an efficient gas motor; the insulation of the leads is fairly perfect, and they show a loss of only 2 per cent. The dynamo is assumed to realize 75 per cent. of the dynamic power supplied to it.

Summary.

510 incandescent carbon filaments *in vacuo* lamps, each of 60 watts, or (say) equivalent to 16 candles	= 30,600 watts.
Loss in leads	= 31,300 "
To compensate for 75 per cent. of efficiency, or a loss of 25 per cent	= 39,100 "

Assuming this watt output to absorb 52.6 indicated horse power, then, accepting 20 cubic feet per indicated horse power, the consumption of gas per hour equals $52.6 \times 20 = 1,052$ cubic feet. Then the number of candles of photometric value obtained per cubic foot of gas burning 1 hour, would be equal to $(510 \times 16) \div 1,052 = 7.7$ *candles per cubic foot of gas burnt in the gas motor cylinder.* Ordinary 16-candle gas burning at the rate of 5 cubic feet per hour will give an open flame light of a luminous value of 12 candles. Hence $12 \div 5 = 2.4$ candles per cubic foot per hour. An inverted recuperative gas lamp will give, with a consumption of 5 cubic feet per hour, a light equal to 40 candles. Then $40 \div 5 = 8$ candles per cubic foot per hour. And an incandescent gas lamp of the latest improved form may be taken to give, with the

same consumption of gas, a light equal to 50 candles—then 50 + 5 = 10 candles per cubic foot per hour. Taking the consumption of gas test *per se*, upon which to base comparisons of efficiency, it will be seen that the consumption of gas in an efficient gas motor cylinder, with a carefully arranged electric light equipment, offers an economic advantage in comparison with naked flame gas lights.

In the event of fogs, the gas engine can be started instantly, and almost in the time the author is writing this paragraph the electric lighting energy is at the disposal of the user; so that in almost every sense the use of the gas power would be highly advantageous, and would be a fitting handmaid in the service of man, in the economic distribution of electric, thermic and dynamic energy.

The author has demonstrated, in various articles, that the cause of our increasingly dangerous and dense smoke fogs is due to the imperfectly consumed hydrocarbons of bituminous coals. The absolute cure for this curse of English city and town life is the use of fuel gas; and this apology is alone sufficient, as it includes the removal of all those barriers to nature's sustaining and vitalizing influences on mankind. The smoke of towns cuts off the actinic rays of light, lowers the animal temperature and enervates and reduces animal vitality. The gas fuel application would remove a great part of this evil, which is at once the disgrace and danger of modern civilization.

It is well known that, whilst we are ransacking foreign countries for agricultural fertilizers, we have in the nitrogenous constituents of our fuel resources a quite sufficient storage of agricultural fertilizers; but in our present method of consuming coals, all the fertilizing wealth is wantonly and deliberately thrown away. The conversion of the solid fuel coal into a gaseous condition enables the recovery (if not synthetical formation) of the nitrogenous agricultural fertilizers to be easily effected. It is generally accepted that 25 pounds of sulphate of ammonia may be recovered from 1 ton of bituminous coal. But it is stated, with some reason, that under certain specific conditions of manufacture, as much as 70 to 80 pounds of sulphate of ammonia per ton of coal gasified can be obtained. Whether this is so or not is unimportant; suffice it to say that the nitrogenous and other residuals of gas manufacture have enabled gas manufacturing firms to realize most substantial financial advantages; and all solid fuel of the bituminous class, so converted, offers similar facilities.

Even with the comparatively high prices charged for gas, its value as a fuel or heating agent has become widely appreciated—especially by the classes to whom the financial question is of minor importance. The following list, long as it is, gives an imperfect idea of the area filled by gas fuel: For motive power—gas engines for all operations requiring dynamic energy, and especially available for application of electric energy generated in well distributed stations, by which the use of expensive storage batteries will be avoided. For industrial purposes—welding, soldering, brazing, forging, fusing, baking, roasting, boiling, tinwork, melting, blowpipe, muffle heating and dentists' and laboratory work. For domestic and associated purposes—cooking, coffee roasting, drying clothes, frying, instantaneous water heating, smoothing-iron heating, toasting and grilling, plate drying, heating tailors' irons, heating, washing and laundry work. By the employment of modern gas fires, nearly all the pleasures so typically English of the open fire, can be obtained without the accompanying dirt, trouble in the lighting, maintenance or regulation, and other inconveniences; and by the use of recuperator gas fires, and the low price fuel gas supplied, no householder need pay more for his gas heating convenience in London than it costs him for coal used in the usual wasteful manner, not to mention the saving of domestic labor in washing, the deterioration of furniture, curtains, etc. It has been proved that a dinner can be cooked for a very large family for a little more than 1d.

Hygienically, the open gas fire, in which there is no exposed horizontal iron surfaces upon which the organic matter in the air can settle and become cremated, is all that can be desired from the point of economy and efficiency; and special apparatus can be supplied to enable any temperature for invalid purposes to be maintained, and by which ventilation can also be adequately and properly secured.

Referring to the paragraphs in which it was demonstrated that there is no advantage in distributing high and expensive photometric gas for heating purposes, this fact is further accentuated by the statement that ordinary English gas coal, economically distilled, cannot be said to produce gas of a higher luminous value than is indicated by 14.74 sperm candles. To obtain a higher photometric standard involves either an economic method of distillation, or resource to expensive cannel coals, which adds, for every candle of additional photometric value power per 1,000 cubic feet, above 14.75 candles, from ¼d. to 1½d. above the average cost of gas. The ratio of the measure of this addition, therefore, has to be added to the measure of advantage of supplying low candle gas for power and fuel purposes.

Let us assume that the Birmingham power and fuel gas is composed of a mixture of the standard 17.4-candle gas, and a non-luminous but purified generator gas, proportional in such a measure as to produce 12-candle gas. The purified generator gas can be produced from bituminous coal at 4d. per 1,000 feet. The statutory 17.40-candle power gas would have to be diluted with 620 feet of generator gas; so that the cost of 1,620 cubic feet of 12-candle gas can be taken as equal to 2s. 2.8d. × 2.48d. = 2s. 0.76d., or equivalent to 1s. 6d. per 1,000 cubic feet. This price allows approximately of a gross profit of 8.969d. per 1,000 cubic feet to be realized. The price might therefore be reduced by 2d.; leaving the gas to cost 1s. 4d. per 1,000 cubic feet. The gas would have a thermic value of (say) 686 British thermal units per cubic foot. Were the gas distributed with a candle power value of 10.5 candles, the cost would be profitably fixed at 1s. 2d. per 1,000 cubic feet. The cost of an actually available brake horse power taking 28 cubic feet per indicated horse power, and deducting 21 per cent. for internal work, may be calculated to equal 0.474d. per brake horse power per hour, or less than ½d., against 6d. the cost of hydraulic power. With the 12-candle power gas, taking 24 cubic feet per indicated horse power, the cost of 1 brake horse power per hour will equal 0.52d., or rather more than ½d., or about one-fourth the equivalent cost of hydraulic energy.

A fuel generator gas could be produced of a non-luminous character from coke or anthracite, and of a slightly luminous value from slack coal, at a less cost than the 10-candle gas proposed, and by its compression equivalent to from 4 to 8 inches of water, practically the same heating power could be passed through the mains as with lighting gas.

When it is realized that the thermic value of the gas obtained from 1 ton of coal distilled in ordinary retorts is only some 6,000,000 of British thermal units, and that there is a balance remaining of some 15,000,000 to 19,000,000 of British thermal units residual in the coke, it will be easily realized that this residual value might be more economically distributed to the consumer. From ¾ pound of anthracite, 1 pound of slack coal, and 1¼ pound of good coke, fuel gas can be generated that will develop 1 indicated horse power. If we take it that 1 cubic foot of anthracite or coke gas has a thermal value of 165 and 145 units respectively, then 4 cubic feet are equal to 1 cubic foot of town's gas.

Now estimating a production of 135,000 cubic feet of generator gas per ton of anthracite, costing 10s., this is practically equivalent to 1d. per 1,000 cubic feet, and taking the cost of labor and purification and interest on plant at 1½d. per 1,000 cubic feet, multiplying by the thermal value ratio to that of coal gas, $\frac{660}{165}$, gives the equivalent value of anthracite generator gas at 9d.; and the equivalent value of coke generator gas equals 11½d. So that the non-luminous gas could be sent to the consumer at a less cost than the 10-candle gas for an equivalent fuel value. Generator gas, produced from ordinary bituminous coal, may be taken to give an average thermic value of 180 British thermal units; and the cost of this coal only slightly exceeds 9s. But assume the cost to be 10s. and the labor of purification and maintenance to cost 1½d. per 1,000 cubic feet, then the cost of the slack coal gas, to give an equivalent thermal value to town gas, will be as $\frac{660}{180} \times 2\frac{1}{2} = 9.6$d. per 1,000 cubic feet. So that it appears that the balance of advantage is between anthracite and slack coal, and in nine cases out of ten the low cost of the slack coal would decide the economic question in favor of the latter fuel. Fuel and power gas generated from either of the solid fuels mentioned, can be distributed under a slight pressure at a less cost than the 10-candle power gas so as to give an equivalent thermic value.

One advantage possessed by the generator gas is the fact that the labor factor of cost in proportion to the volume of gas produced is less than that associated with retort gas. The feeding of the fuel can be effected automatically. It has already been stated that, on a small scale, fuel gas generated from anthracite coal has driven gas engines at a cost in fuel of less than 1 lb. per indicated horse power—thus far-and-away surpassing any contemporary work in other fields of thermo dynamics; and this generator gas, but for its characteristic non-luminosity and practical inodorousness, is the *beau-ideal* fuel. The generator gas produced from slack coal has its own generic odor, and is slightly luminous. A calorimetric test of this gas has indicated 220 British thermal units per cubic foot. It is, however, altogether inadequately luminous for lighting purposes; and it is considered by the author that 10-candle gas, although exclusively a heating gas of a satisfactory distributing character, is also a luminous one, and better, in fact, than the natural gas of Pennsylvania, and which is used for heat, power, and light.

The 10-candle power gas approaches very closely in character to the

American natural gas, both thermically and chemico-constitutionally. It is very easy to burn the gas economically, whereas the rich hydrocarbons of the high candle power gas are far more difficult to consume. With this rich gas, the nice and adequate proportion of air to oxidize the combustible elements is more difficult to effect; and the result is generally incomplete combustion, and consequent thermal waste. It is far more advisable to contribute an excess of air to support combustion, and lose by abstraction of an excess of sensible heat in the products of combustion, than to lose imperfectly consumed gases having unexhausted thermo-chemical energy.

The 10 or 12-candle power gas is thus a fuel that will be found economical to use both as a heating and power agent, besides being conveniently luminious. It must, however, be understood that the author does not recommend low candle gas for all lighting purposes. Where enriching agents can be cheaply obtained, it is more economical, and a higher thermo-luminous or lighting efficiency can be obtained, with a high proportion of a condensed character of hydrocarbons in the flame; and the higher the candle power, within certain limits, the better.

It follows, therefore, that to effect the introduction of an economical gas for power and fuel purposes: First, it should have a photometric value of 10 or 12 candles. Second, in order that the gas shall be distributed without involving large diameter and consequently expensive mains, the gas shall be distributed under a pressure equivalent to from 4 to 16 inches of water. Third, to encourage the use of gas motors felicitous arrangements of hiring or easy hire payment systems should be started to gradually introduce the gas for domestic heating systems. Fourth, to effect the most desirable conditions will involve the employment of special high-pressure mains and special gas compression plant.

The Birmingham Corporation can initiate the distribution of fuel and power gas system, and establish its advantages in the following manner: First, by taking over the distributing mains of the late Birmingham Compressed Air Company. Second, by utilizing the present compression plant of the same Company. Third, by establishing fuel gas generator plants to produce fuel gas from coke, anthracite, or bituminous slack coal, as may be found most economical, to mix with the ordinary standard candle power retort coal gas. Fourth, by establishing three or more small storage holders of (say) 5,000 cubic feet capacity each, for mixing the generator gas with the town's gas, and equipped with suitable valves and connections. And fifth, by the encouragement of the use of the gas fuel in various ways in different parts of the area served by the present mains.

The effect of such applications will result eventually in the general demand for the fuel and the power gas; and Birmingham—once the supply is extended to feed the entire town—will place herself in the foremost rank amongst the municipalities of England. Her sky will be unclouded by the hideous pall of smoke; unsullied will in future be her architectural creations; her industrious townsmen will have power and fuel advantages unexcelled; and her housewives will have a domestic expedient that will reduce the labors and expense of home, and add to its comfort and cleanliness. Then, why should Birmingham wait?

Cerebral Radiation.

[A paper read by Prof. Edwin J. Houston, before the Electrical Section of the Franklin Institute.]

GENTLEMEN: I have thought it possible that it might interest you to consider some rather wild speculations in which I have indulged for a number of years past, but which I have heretofore refrained from publishing. In these speculations, to which I was first led by a suggestion from a friend, I have endeavored to correlate, to some extent, the phenomena of thought with grosser physical phenomena. Although the suggestions I have to offer as a basis for a hypothesis of the mechanism of cerebration, are confessedly incomplete, and, perhaps improbable, yet I have concluded to place them on record as of possible interest to the scientific world.

I am, of course, aware of the fact that the psychical operations of the brain are by no means understood. It is generally believed, however, that the seat of psychical activity is the cerebrum. The manner in which the brain acts to produce, record, and reproduce thought is unknown, and will probably remain unknown.

On the single assumption, however, that cerebration or thought, whatever may be its exact mechanism, is accompanied by molecular or atomic vibrations of the gray or other matter of that part of the brain called the cerebrum, I would propose the following hypothesis to account for telepathy, mesmerism, thought transference, hypnotism and other cognate phenomena.

Postulating the existence of the universal or luminiferous ether, which is now generally accepted in scientific circles, and bearing in mind the fact that this ether passes through even the densest matter, as easily as water through a sieve, it follows that the brain atoms or molecules that are here assumed as the cause of cerebration, are completely surrounded by the ether. Now, since the ether is a highly elastic, easily movable medium, it would follow that thought or cerebration, if attended by vibrations, must necessarily develop in the ether wave-motions, which have the brain atoms or molecules for their centers. In other words, the act of thought or cerebration necessitates an expenditure of energy, because it necessitates the setting in motion of these assumed atomic or molecular brain particles.

The exact nature of the motions that are assumed to attend an active condition of the brain must necessarily remain unknown as long as we are ignorant of the exact nature of the mechanism that is moved. But, if an active brain evolves thought because something is set in motion, it, of course, follows that a brain absolutely free from producing thought must be at rest so far as that kind of motion is concerned. An absolute freedom from thought in a healthy brain is most probably a condition that seldom exists; relative rest, however, must be quite common.

That the brain cells, of the gray or other matter involved in the production of thought, can be caused to assume certain groupings or relations towards one another would appear to follow from the ease with which that curious function of the brain called memory, permits it to readily recall past peculiarities in the to-and-fro motions. By continually repeating certain trains of thought, as in study or repeated observations, the peculiar motions required to produce such thought are probably given a set or tendency to form more or less permanent groupings. When, therefore, the brain is moved or played upon, so to speak, these motions recur and certain memories are awakened.

How may these motions be produced? The answer would certainly appear to be both from within and without. It is, perhaps, possible that the flow of blood to an active brain, which as is well known attends all active cerebration, is not only for the purpose of nourishing and rebuilding the organ, but also for affording the purely mechanical force, that needs but to touch this marvellously attuned organ to awaken the thoughts already impressed thereon, or to sit in judgment on new combinations never before presented to it.

I will suggest an explanation later on as to how these impressions may possibly be excited from without.

Whatever be the origin of these vibrations, or however excited, energy is required to be expended in producing them, and as the brain-worker will readily acknowledge, the expenditure of such energy often calls for an enormous expenditure of nervous force.

Cerebral energy, or energy thus expended in producing thought, is dissipated by imparting wave motions to the surrounding ether, and such waves are sent out in all directions from the brain, possibly in greater amount or of greater amplitude from some of the brain openings, as, for example, those of the eyes.

Although there are no absolute proofs of the existence of the molecular or atomic vibrations of the brain particles which I have assumed, such a movement, however, is far from being improbable, and, indeed, some facts known to the medical profession are far from being at variance with such an assumption. A certain amount of pressure on the brain, arising from the pressure of the blood, is necessary for its proper action. If this pressure increases beyond a certain value, as, for example, in cases of fractures of the skull, where a portion of the bone is depressed by the fracture, thereby producing a compression on the brain material. all thought or cerebration instantly ceases; but when this pressure is relieved, by the act of trephining, cerebration not only begins, but, curiously enough, generally goes on from the point where the patient left off, when the injury occurred.

Let us assume, then, that cerebral radiations or waves are given off from every sentient or active brain, and that these waves pass into the space around the brain something like the waves that are imparted to the air around a sounding tuning fork.

The cerebral radiations are not so gross as those of sound. Their wave lengths are almost certainly much shorter. They are imparted to the universal ether.

If such waves, which I would call thought waves or cerebral waves, be present in ether that fills all space, it will be interesting to inquire what phenomena they might be expected to produce.

It being assumed that these vibrations take place in the ether itself, there need be no doubt or speculation as to the general nature of the waves themselves. They would presumably partake either of the nature of transverse or torsional vibrations.

The commonest character of the vibrations which occur in the univer-

sal ether are the vibrations which are now generally recognized as transmitting the phenomena of heat, light, electric or magnetic radiations, viz., of transverse or torsional vibrations.

An active brain may, therefore, be regarded as moulding the ether around it into thought waves, that are spreading outwards from it in all directions. In this respect, it is not unlike a conductor through which an oscillatory discharge is passing, producing those waves which Hertz has so beautifully demonstrated as resembling the vibrations that pro duce light.

Assume, then, that the cerebral radiations partake of the nature of thermal, luminous, electric or magnetic radiations, and the following explanation of telepathy, or thought transference, is, to say the least, not improbable.

I would explain the possibility of the transference of specific cerebral vibrations from an active brain to a passive or receptive brain, by the simple action of what is known in science as sympathetic vibrations. Take the case, for example, of a vibrating tuning fork that is sending off its waves across the space which separates it from a second tuning fork, not as yet in motion, but tuned so as to be able to vibrate in exact unison with it. As is well known, the exact correspondence between the period of the active, or the transmitting fork, and the passive, or the receptive fork, is such that the vibrations of one fork are gradually taken up by the other fork, so that the energy of the motion of the one is transferred or carried across the space existing between them, by means of pulses or waves set up in the air which surround them.

As is well known, such sympathetically excited vibrations can be produced in a fork situated at a considerable distance from the exciting fork.

Or, similarly, take the case of the sympathetic vibrations excited by waves of light. Solar energy is radiated or transferred across the space existing between the sun and the earth by waves or oscillations in the luminiferous ether. These waves, falling on the delicate structure of a leaf, suffer a species of selective absorption, certain wave lengths being absorbed and others thrown off. The absorbed waves excite or produce sympathetic vibrations in the molecules of carbon dioxide present in the leaf, and cause the atoms of carbon and oxygen in such molecules to move towards and from one another in inter-atomic vibrations, which increase in amplitude or violence until their chemical affinity or atomic attraction is overcome and dissociation occurs. The oxygen is then thrown from the leaf into the air, and the carbon is retained in the structure of the plant.

Or, take the still more interesting case of what Hertz calls electric resonance. As already mentioned, it is now generally recognized by electricians that a conductor, which is the seat of an oscillatory electric discharge, is sending into the space around it electric waves or oscillations which travel with the velocity of light, and which are in fact of exactly the same nature as light itself. If these electric waves meet a circuit so tuned as regards the period of oscillation of the circuit in which they originally occurred, as to be in consonance with them, electric oscillations will be set up in this circuit of exactly the same nature as those exciting it.

In view of these facts it does not seem improbable to me that a brain engaged in intense thought should act as a center of cerebral radiations, nor that these radiations proceeding outwards in all directions from such brain should affect other brains on which they fall, provided, of course, that such brains are tuned to vibrate in unison with them. In such cases the absorption of energy by the recipient brain may be either a species of selective absorption, in which its train of thought is only modified, or it may be absolute, in which case the recipient brain has excited in it an exact reproduction of the thoughts of the exciting brain.

Such a hypothesis is far from improbable; on the contrary, it would appear to be supported by a variety of curious circumstances, which have only wanted some general hypothesis to properly correlate them.

If such a hypothesis be true, then these cerebral vibrations or radiations must travel through space with exactly the velocity of light. This is of course on the assumption that the vibrating or oscillating brain molecules or atoms set up vibrations similar to those of light. Of course, this equality between the velocity of cerebral wave propagation and that of light is true only for free ether. In the ether which fills the interatomic or intermolecular spaces of gross matter, or, as it is technically called, combined ether, the velocity of wave propagation varies according to the particular character of the matter with which it is associated. A retardation or decrease in the velocity of the assumed cerebral waves would doubtless be experienced while passing through the materials of the skull and head.

If thought travels along waves in the ether similar to waves of light, it would be able to travel along any path by which rays of light can pass. It can therefore travel along rays of light—that is, along paths in the ether through which rays of light are moving.

There is a well known experiment in hypnotism, in which the patient, placed in a state of semi or complete unconsciousness, has his brain called into a more or less active condition by the suggestions of the hypnotizer, which might seem to somewhat favor the hypothesis of cerebral radiation.

It might be interesting, in view of the above suggestions, to see whether a hypnotizer, placed in such a position as regards the hypnotized that flashes of light falling on his eyes shall afterwards fall on the eyes of the patient, to observe whether or not acts of suggestion are more readily perceived by the brain of the hypnotized along such rays of light than without the aid of such rays.

If the preceding speculations be regarded as wild, and that this is true I have already granted, what may not be said as to the following?

If thought radiations partake of the nature of ether waves, then there should presumably exist, in the thought radiations or waves, phenomena corresponding to the various phenomena of thermal, luminous, electric, or magnetic radiation; even the phenomena of reflection, refraction, and possibly even of dispersion of such waves, would appear to be a possibility. In this connection it is of interest to imagine the analysis or separation of a complex wave of thought into its component or elementary waves, corresponding to the separation of a beam of light, by means of a prism.

In this connection there would be a new significance in the phrases, "radiant with thought," or, "to concentrate one's thoughts on a subject."

If thought radiations or waves partake of the nature of light, then it would seem among the remote possibilities of science to obtain—say by means of a lens—a photographic impression of such thought waves on a suitably sensitized plate, somewhat after the manner of the ordinary photographic picture. Such a thought record, suitably employed, might be able to awaken at any subsequent time, in the brain of a person submitting himself to its influences, thoughts identical to those recorded.

Of course, I am aware of the improbability of such a record being obtained in the near future, and of the exceeding difficulties that would seem to stand in the way of ever obtaining it.

Until we know something more definite concerning the nature of these assumed cerebral vibrations and of their lengths, we must necessarily be seriously handicapped as how to best permanently fix them on a suitable record surface, and how afterwards to cause such record surface to interpret its peculiarities to the brain. I merely throw it out as a possibility of what science may have in store for those who come after us. I would suggest, in this connection, that 100 years ago it would probably have been regarded as quite impossible that the telephone or or phonograph could have been produced.

Such a thought record, however, if obtained, would not be an image of the thought itself, or of the particular groupings of the particles, whose to and fro movements attend or produce thought, any more than the tracings of the phonograph record form an image of the spoken words. They would merely represent the to and fro motions of the ether set in motion by the thought or cerebrations.

An eye looking at such an image would not be influenced thereby. If, however, ether waves similar to those recorded could be reproduced by causing light to pass through such photographic images of the to and fro motions of thought waves, such waves might be caused to influence the brain and thereby awaken thoughts similar or identical to those recorded.

I have often amused myself with picturing a possible thought-recording machine, whereby the thoughts of an active brain might be recorded continuously and permanently on a moving sensitized film, the exposed surface of which was placed at the focus of a large lens placed in front of anyone engaged in intense thought.

If, like the cylinder or plate of a phonograph or gramophone, such a record were afterwards rotated at the same speed as that at which it received its impressions, under circumstances in which light passing through it is moulded into waves similar to those recorded on it, such waves when caused to act on a receptive brain should, it would certainly seem, excite therein thoughts identical to those recorded as its record surface.

Of course, it is needless for me to say that such a machine has never been actually constructed and is still as unsubstantial as are the speculations which I have offered you. Indeed, the probabilities against its being produced are so great that I have hesitated even to mention it.

Some experiments might be tried in a similar manner in thought transference, by holding large lenses in front of the eyes of a hypnotizer at such a distance as to converge the assumed cerebral radiations on

the eyes of the hypnotized. These experiments might be tried either along with light, or independent of it.

I know that many points of the hypothesis which I have suggested are quite improbable, and that I may and probably will be misunderstood by some as putting forward facts rather than a bare hypothesis.

Probably one of the most serious objections to the hypothesis is to be found in the fact that the phenomena of telepathy and thought transference are not of more frequent occurrence. This I must frankly acknowledge to be a most serious objection. I would suggest, however, that the comparative infrequency of the phenomena may possibly be explained by the presence in the human body of a shield which protects the brain or the nerve centers from the effects of cerebral radiations. It is not impossible the sheathes of the nerves act as screens to prevent the reception by the brain of these thought radiations.

Prof. Tyndall, in his work on sound, alludes to the well-known fact that when sympathetic vibrations are being excited by a sounding tuning-fork in any body near it, that there is a greater rapidity of expenditure of energy of the fork's motion than when it was not exciting such waves. The analogue of this phenomena exists, perhaps, in the case of the assumed thought transference. Mental energy is presumably expended at a greater rate when it is exciting thought-waves in this manner, than when such are not being excited.

There has often been experienced by me as a teacher a feeling of great exhaustion in taking charge of or watching a room in which a number of bright students were undergoing an examination. It is possible that the cause of this exhaustion is the rapid dissipation of energy by the cerebral radiations being absorbed by the receptive brains of the examinees. I am informed by certain physicians that a feeling of great exhaustion is experienced by them in the treatment of some cases.

If there be any truth in the hypothesis I have briefly outlined, there should be what I would term a kind of vital radiation going on and passing outwards from the body of a healthy person, which may not improbably excite by sympathetic vibrations in the bodies of weaker persons around them, vibrations of a normal or more healthy type than those present in the sick person.

If this be true, the old belief of the efficacy of the laying on of hands, or of magnetic healing, may find some foundation, in fact, apart from what it is most probably the general explanation of such phases, viz., hysteria.

I have thrown out the above hypothesis of cerebral radiations with considerable doubt and hesitation as a suggestion only to those working in the field of telepathy or thought transference, in the hope that I may thereby call the attention of such investigators to some phenomena in this very obscure field of research.

The Kirkham Gas Generator.

On July 26, 1892, U. S. Letters Patent (No. 479,647) were granted to Mr. John J. Kirkham, of Vigo, Indiana, for an improvement in gas generators. Using the words of the specification, Figure 1 shows a vertical central section of the apparatus; Fig. 2 is a horizontal section on line *I J* of Fig. 1; and Fig. 3 is a horizontal section on line *G H* of Fig. 1.

The invention is in the nature of a gas generator for the manufacture

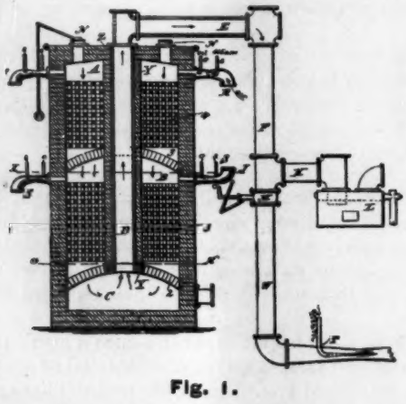

Fig. 1.

of fuel and illuminating gas and for enriching air and natural gas, in which generator oil shall be exclusively used for heating the generator and supplying the carbonaceous ingredients of the gas. With this class of gas generators the difficulty has been that the generator and superheater could not be heated uniformly or deep enough through the firebrick checkerwork to properly fix the gas, since, on the one hand, if the heat were carried high enough at one point, it would cool in the more remote portion of the checkerwork and distill tar, while, on the other hand, if the heat were carried high enough to prevent this result, the first portion of the checkerwork would be heated too hot and would burn the oil and cause a deposit of lampblack, in either case involving the choking of the generator and the production of an imperfect gas.

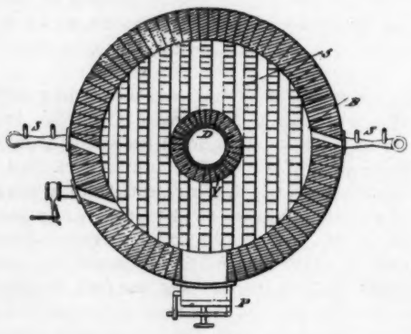

Fig. 2.

The Kirkham generator is constructed of masonry, as a vertical stack, and is divided into several chambers *A B C*, by means of transverse arches of brickwork 2 and 3. These arches do not entirely separate these chambers, but are formed with open spaces in them, as shown in Fig. 3, through which the contents of one chamber can pass to the chambers below it. Above the arch 3, in chamber *A*, is arranged the superheater, composed of checkerwork 4, made of alternated firebricks, to give large superficial heating surface, and a similar mass of firebrick, 5, is arranged in chamber *B*, below arch 3, to form the superheater for that chamber. Into the space of upper chamber *A* there open latterly above the checkerwork the injectors *R R*, and into the space of the chamber *B* above the checkerwork there open the injectors *S S*. These injectors are all alike and may be of any desired pattern. The simple form shown, however, works well, and this consists simply of an outer case of a double conical shape, open at its outer end to draw in air, and having an oil pipe, *o*, entering laterally and terminating in a nozzle directed inwardly and a steam pipe, *s*, outside of the oil pipe and terminating in the case in a nozzle, also directed inwardly to the generator, so that when steam passes in through the pipe it draws in air at the open end of the case, and, spraying the oil entering through pipe *o*, mixes it with the air, and thus furnishes the materials to be converted by the heat of the checkerwork into gas. Into the upper chamber, *A*, there opens also through the top of generator air valve *N*, and into the chamber B there also opens through the side of the generator air valve *V*, Fig. 2. A manhole, closed by door *P*, also opens into the chamber *B* to allow workmen to enter to repair the arches and checkerwork. There may be any number of these vertical chambers similarly equipped.

Centrally in the generator, in vertical position and passing through the arches 3 and 2 and supported upon the latter, is arranged a retort, *D*, 12 or 14 inches in diameter, surrounded by firebrick *Y*, and communicating at its bottom end with the lowest chamber *C*, and at its upper end emerging through the top of the generator and communicating with a horizontal pipe *E*. This pipe *E* communicates with a

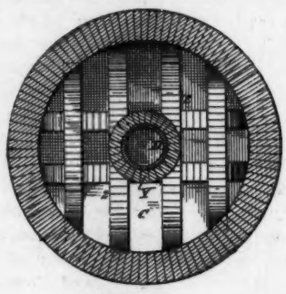

Fig. 3.

vertical pipe *F*, which has a right-angular branch *K*, leading to the hydraulic seal *L*, and also communicates through valve *M*, just below branch *K*, with a pipe *W*, which has at its lower end a draft-inducing steam nozzle *7*.

The operation of the generator is as follows: When the machine is being heated, a draft is induced through the same in the direction of the arrows by the steam jet *T*, or other suction device, valve *M* being open. This draft passes down through the chamber *A*, checkerwork 4, through the spaces of arch 3, down through chamber *B* and checkerwork 5, and thence down through arch 2 and up through the retort and out at pipes *E F W*. If the machine is, when started, entirely cold, a quantity of wood is first placed in the combustion chambers *A* and *B*, and ignited; but ordinarily the machine after once being heated up to about 2,000°-will remain hot enough even after 12 to 14 hours to ignite automatically the spray of oil and air when started up next day.

Assuming that the machine has been in operation the previous day, and it is desired to continue on the next day the making of gas, the following is the order of procedure: Air valves *N* and *V* are opened, as is also the valve *M*, and the steam exhauster *T* starts the draft, as above indicated. The injectors *R R* in chamber *A* are now set into operation by the admission of steam and oil through their respective pipes, and the steam sprays the oil and also draws in air, which, becoming intimately mixed, at once unite and burn from the high temperature. Injectors, *S*, are also started into action in the same way to heat the lower chamber *B*, and so on with as many other chambers as there may be in the apparatus.

These hot currents traversing the checkerwork pass downwardly through the same and by their distribution of heat equally through all the chambers, bring all of the superheaters to the same degree of heat, the currents passing downwardly through the arches to chamber *C* and thence upward through the retort, heating the sides of the latter. About 8 to 15 minutes suffice for the heating, and after the desired high temperature is obtained the injectors *R* and *S* in the chambers *A* and *B* are shut off and the air valves *N* and *V* closed, the steam exhauster *T* is stopped, and valve *M* is closed. The injectors *R* in the chamber *A* are then started into action again, and oil, steam and air pass in intimate admixture, and upon passing through the superheaters and retort are fixed into a gas, which passes out pipes *E F K* to the hydraulic seal *L* and to the cleaning apparatus, gasholder and mains. This operation of making gas is continued as long as the heat lasts, and practice has shown that it may continue through about the same period of time that it takes to heat up the apparatus—*i. e.*, from 8 to 15 minutes.

The advantage of the central retort opening through the top of the generator is that it saves a great quantity of heat and renders the apparatus more effective and economical.

There may be any number of chambers *A* and *B*, with their superheaters of firebrick, and they may be of any size. The preferred size is a diameter of 6 feet for the chambers and a space of 18 inches between the checkerwork and the arch above it. With this construction it will be seen that with the superheaters arranged in series in separate chambers communicating with each other and each provided with its own injectors and air valves, every part of the generator is heated alike, and there is neither any deposition of lampblack from excessive heat at one point nor any distillation of tar from deficient heat at another.

The Effects of an Auroral Disturbance on Cables and Land Lines.

The New York *Sun* says that the remarkable auroral disturbance on July 16 produced curious phenomena on the telegraph circuits and instruments of submarine cables and aerial land lines that may afford data for scientific men in determining the actual nature and laws of the mysterious auroral phenomenon itself. In a broad sense telegraphic circuits are affected by auroral displays in the same manner as by violent thunderstorms, but the precise effects from the two causes are very different. Interruptions to telegraphic communications on lines in far northern latitudes are of frequent occurrence. The lines in Canada, for instance, which run north of Lake Superior, from Montreal to Winnipeg, are at certain seasons of the year interrupted almost nightly by slight auroral disturbances. But the disturbance on July 16 was the most remarkable in its effects on telegraph circuits of any noted for a great many years, if not the greatest of all such displays. A prominent electrician in this city took careful note and tests of the effects of this disturbance, and he calculated that the force of the electrical current from the auroral disturbance was equal to 500 volts.

It is interesting to note, too, that the telegraph instruments showed the auroral disturbance to be very much greater during the day, from about 11 in the morning to 4 in the afternoon, our time, when there was no spectacular display of celestial scenic effects, than it was at night when the wonderful phenomenon was so apparent. The electrical disturbances were noted at precisely the same time in this city, in Chicago, and in Nova Scotia and Newfoundland. In Chicago it was noted that, while the sky was cloudless and the sun was shining brightly, tremendous currents of electricity charged the air, completely interrupting all telegraphic communication. The currents came in waves at irregular intervals.

But the most interesting effects were noted on the delicate instruments of the Atlantic cables, and with these, on account of their peculiar construction, various phenomena of the auroral disturbance could be noted that were not possible on land line instruments. With the latter the effect was simply to put a current or a ground on the circuit, which broke things up generally and prevented all communication. On the cable instruments the length, intensity, and direction of the waves of electricity were recorded accurately. The effects were noted on the instruments of the cables that run into this city from Nova Scotia, and on the long cables at Nova Scotia and Newfoundland, which run under the Atlantic to Ireland. It was on the long cables that the auroral effects were displayed most strongly, and as the cable drops directly from the office into the ocean, and lies at the bottom in some places three miles down, the presumption that the auroral force was exerted through that watery space as well as on the instruments directly is of interest.

The siphon recorder, the instrument used for submarine cable telegraphing, is the most sensitive kind of galvanometer in practical use. The auroral disturbance interrupted communication entirely. During the disturbance, especially between the hours of 11 and 3 midday, the siphon or needle was deflected intermittently very strongly from the zero, or middle, position, and it swayed first to the right, and then to the left. The movement of the needle was very slow. It would suddenly move away to the left, pulled by, say, a northerly current, and would be pulled very far, indeed, beyond the limit of any cable current, indicating that the current was very powerful. It would remain at the extreme point of deflection from 5 to 10 or 15 seconds, and then return slowly to zero. Sometimes immediately, sometimes a few seconds or minutes later, the needle would be pulled slowly in the other direction by a southerly current, would deflect to a remarkable distance, remain there a few seconds, and then return slowly to zero. That seemed to indicate that the electrical currents set up by the aurora were very powerful, were steady and of long duration, and alternated in direction of force in their polarity; they were like great waves of the ocean ebbing and flowing. The effect of a severe thunderstorm on a cable instrument, felt often when the storm is far at sea, is a quick, instantaneous jerk of the siphon, the effect lasting only an instant. The cables were affected in the evening of the auroral display when the heavens were aglow with the magnificent streamers and banners of light, but the interruption was very slight as compared with that experienced during the day.

Central Station Lighting in Small Cities.

By Wm. H. Bryan, in *Western Electrician.*

The larger cities of the country are very far from having a monopoly of electric light. There is hardly a town of 30,000 inhabitants which has not its central station—and sometimes more than one; while a great many smaller places are similarly equipped. There are, in fact, a number of villages of less than 1,000, where fully equipped plants are regularly operated.

There are abundant reasons why this should be so. The first cost of a plant of a suitable capacity is small, and it may readily be extended over comparatively wide areas. Land, buildings, labor, and frequently fuel, are cheap; and there is sometimes the seductive influence of an unused water power in the vicinity. There is abundant space, and plenty of light and air—ideal conditions which permit of an arrangement of plant admirably fitted for good work. To these tangible advantages may be added the often imaginary one of a present or prospective "boom," and the desire to equal or out-do some neighboring or rival town.

And yet it must be admitted that the results of these installations are not all that could be desired. Some important elements, bearing directly upon the question of success or failure, have evidently been underestimated, or wholly overlooked. True, a few such plants have prospered, and many others maintain satisfactory service, and are able to keep going. Others, however, find themselves playing a losing game—fixed and growing expenses, and limited incomes; no money for interest, respairs, or renewals.

This unsatisfactory state of affairs has caused foreign capital to be

very slow—if not entirely unwilling—to seek investment in such plants, and has even hurt the cause of electric lighting in general, even under conditions entirely favorable to success.

Wherein does the trouble lie? And is there a remedy? To consider these questions intelligently it is desirable, first, to get a clear idea of what constitutes success.

There must, of course, be satisfactory service—the lights must be of proper candle power and uniform intensity. There must be no interruptions and no delays in starting. All reasonable demands as to character and sub-division of the light and extensions of circuits must be met. Prompt and courteous attention to the wants of patrons is indispensable. In short, the light must be so superior in quality, and so reasonable in price, as to insure a large and growing demand. Such a plant would certainly be considered a success from the standpoint of the customer.

Whether a plant so operated is successful from the standpoint of the investor is, however, quite another question. Do the established rates yield a proper net income? And it must not be forgotten that financial success means far more than a mere surplus of income over running expenses. The permanently successful station must have a gross income sufficient not only to pay all ordinary operating expenses, but a net income which will pay:

First—A fair interest on the capital invested, say from five to ten per cent., depending on the ruling rates in the vicinity, and

Second—A certain regular sum for a sinking fund. This may be expended wholly in keeping the apparatus and plant in as good condition as new; it may be used partly for ordinary repairs, and the remainder set aside for the purchase of new machinery when the present shall have worn out. The proper amount to charge to sinking fund varies widely, depending on the character of the service, the design and construction of the apparatus, and the intelligence and care exercised in its operation. It should rarely be estimated at less than eight per cent. per annum on the first cost of the plant, and sometimes should be as high as twenty per cent. In the earlier days of electric light installations, when designs were bad, methods of construction crude, and the handling and care poor, even the latter figure was frequently too low. These objections, however, have been largely overcome in late years, with the result that better service and greater durability are now readily obtainable.

It is held by some that the earnings should also be sufficient to provide for such increase of capacity as is necessary to enable the plant to keep pace with the growth and advancement of the community it serves. Quite a number of the plants in the larger cities have done this, and they are now pointed out as shining examples of success. Such results are cause for congratulation, and would be highly desirable to obtain; but they cannot legitimately be charged against the earnings. Increased demands and increased opportunities for revenue justify the investment of additional capital—on which in turn the same net revenue must be earned.

Failure to earn a net income sufficiently large to meet the requirements of interest and sinking fund will in time inevitably lead to disaster. The effect will first be felt in inability to properly operate and maintain the plant, resulting in an impairment of the service and dissatisfaction among the patrons, which can but add to the trouble and hasten the end.

A brief study of the situation as it usually exists in small cities and towns may not be out of place. Mention has already been made of the favorable conditions, real and imaginary. What are the unfavorable influences which in so many cases have caused financial disappointment, if not ultimate failure?

First of all, the demand is so varied in character as to be beyond the capacity of the average station to meet. People want arc lights of different candle powers; long and short hours; incandescent lights of all candle powers, and at any distance; current for power at varying pressures. But few subscribers need light after midnight, but there will be quite an unfavorable sentiment raised if the lights are shut down at 12, although there is rarely sufficient income to justify operating after midnight.

The area to be covered is frequently large, and the users scattered, so that an unusually large investment in mains is necessary in proportion to revenue. So much so, in fact, that no other form of public illumination would be thought of at all.

The hours of lighting are short. Stores and business houses close early. There is little or no activity on the streets after dark, and there are usually no theaters or halls or other regular places of amusement to keep people up late.

Neither is there usually a demand for as high a grade of illumination, nor as large a quantity of it, as exists in large cities. The people have been accustomed to coal oil or candle light for indoors, and a few feeble oil or gasoline jets for the streets; and they do not readily see the advantages of more and better light. There is not the rivalry between adjoining districts or streets, nor between neighboring or competing business houses, which has so frequently resulted in increased demands for light in the cities.

Furthermore, there are but few large stores and residences where any large and concentrated demand can be expected. The outfit must therefore be distributed among a larger proportionate number of small consumers, with a resulting increase in the cost of operation and maintenance per unit. But few places will be found where arc lights can be economically employed. The vast majority cannot afford to pay a living price for such a light.

And it is at first difficult to convince them that the new form of light is really worth what it costs. It is not claimed that electric light can be furnished as cheaply as coal oil, except in remote districts, under conditions particularly unfavorable to oil. It takes time to prove the superior merit of electric light, its greater illuminating properties, its safety, cleanliness, ease of handling and its adaptability to varying conditions. Make the price as low as you will, and there are still many who think it too expensive. They and their fathers and grandfathers have gotten along in the past with oil and candles, and they are slow to see wherein an improved light is worth more to them in dollars and cents.

Right here is where the careful and conservative station manager meets his greatest difficulty. The maximum rates are usually fixed by charter or ordinance, and are seldom excessive. Shall they be rigidly adhered to, at the possible cost of restricting the output far below the station's capacity, or shall a general reduction be made, trusting to increased consumption to bring up the revenue? What schedule of rates will bring in the maximum net returns?

Many failures may be traced to unwise competition. A town may already have a small gas or electric light plant which is serving the people fairly well. There are always some malcontents ready to raise the cry "monopoly," who imagine that unheard of profits exist in the lighting business. The result is the installation of a second plant. As there is not sufficient business for both, rates are cut to secure or hold what business there is, and losses result. Usually it is simply a question of the longest pocketbook. The struggle is finally ended in consolidation or the extinction of one of the plants, and another failure of electric lighting as an investment is chronicled.

Not far from these are the cases where illuminating companies add electric lighting plants in order to forestall the installation of a plant by others, thus keeping the entire lighting business in their own hands. There are, of course, certain economics of operation which should result, due to combined management, reduced or no cost for space, buildings, etc. But it is not uncommon for the electric lighting department to be run as a side issue, without special expert attention. No enthusiastic and persistent effort is made to enlighten the public regarding the meritorious features of the new light. Small wonder then, that such plants fail to earn a proper income, particularly where the demand for light is limited in quantity and revenue.

These are some of the conditions existing in the town itself, and which not infrequently determine in advance the probabilities of success. Failure may, however, result even when a fair review of the situation amply justifies an installation, and from causes inherent in the plant itself.

The manner in which the average plant of this kind is purchased is usually such that the chances of success are against it from the start. A number of public spirited citizens, each successful in his own line, agree upon the necessity for such an improvement. They get together, organize, secure a franchise and a city lighting contract if possible. They are waited on by representatives of all the companies manufacturing and selling apparatus, and are invited to go on tours of inspection. Visits are made to other towns, where the operation of plants is inspected. There is rarely a man among them qualified by education or experience to pass upon a problem of this kind fairly or intelligently. Neither are the men in charge of the plants visited usually capable of judging any apparatus or system outside of the particular type they are themselves operating. As a result the plant last visited, the one with the greatest income, the lowest priced apparatus, or the most glib salesmen, determine the choice, without respect to whether the apparatus selected is suited to the requirements, which may be—and usually are—different from those elsewhere. Men who would not think of acting as their own lawyers or physicians, who would not build a bridge without having an engineer, nor a house without an architect, unhesitatingly take in their own hands decisions involving the most complicated of technical and

expert considerations. Usually the salesmen securing the contracts do the engineering, and it is greatly to their credit that they so often secure successful results in the face of many unfavorable conditions.

Not infrequently, however, the salesman is not asked to supervise all the work. And sometimes, when asked, he is prevented by previous engagements and lack of time from following the matter up as he would like. Often, however, the proper solution of the problem involved calls for wider experience and more thorough training than are possessed by the average salesman. The companies whose systems are used, and who build the apparatus, should, and frequently do, take a decided interest in the plant, but as their business is manufacturing and selling, and not operating, and as their best men are usually very busily employed on other and more profitable work, it is seldom that they can follow up each separate installation.

Frequently, therefore, the system selected is by no means the best for the existing conditions; the owners adhere to a single system, where a combination of several systems would often be better; the plant is poorly designed and arranged, and accidents and interruptions are frequent; the character of the attendance is inferior; the parent company appears to take little interest in it; and no expert supervision whatever is being exercised.

It is evident that this unfortunate state of affairs can only be remedied by a more careful, thorough and unbiased consideration of each special case. Where the conditions are clearly unfavorable it is better for every one in the end to discourage the enterprise. If the outlook is not reasonably promising, do not put in the plant at all. Much of the trouble in the past has been due to the misdirected energy of the salesmen in working up and selling plants in locations where they could not thrive by any possible means.

If the preliminary expert study of the situation is favorable, then let careful plans and specifications be prepared by a disinterested specialist, covering the general system, or combination of systems best fitting the conditions. Give the contract to a company of standing and experience, under the supervision of its own expert—or better still, of the local company's expert or consulting electrical engineer. Give special attention to the training of the man or men who are to operate the plant; and let there be regular and continued expert inspection and supervision after starting.

For already existing stations the remedy is not so clear. A preliminary study of the local situation in all its bearings is necessary to any improvement. Sometimes the case is desperate, but not infrequently it is possible to remodel the plant, locate and remedy troubles, revise the rates, rearrange the general plan of operating, so as to materially improve the plant's prospects—all without excessive cost.

Altogether, the subject is well worthy of more study than has thus far been given it.

Conflicting Aspects of Lamp Litigation.

In commenting on these matters the *Electrical Engineer* says that the decision of Judge Acheson, in the suit of the United States Electric Lighting Company against the Edison Lamp Company for alleged infringement of Weston's patent for hydrocarbon treatment of carbon burners for incandescent lamps, may or may not mark an important epoch in the history of incandescent lamp litigation; but it will certainly have the effect of raising some decidedly interesting and important legal questions. Judge Acheson holds that the public exhibition by Sawyer and Mann of a "large number of incandescent lamps" containing treated or flashed carbons, between March, 1878, and May, 1879, was "a practical and public use." This, it will be noted, was some time prior to any attempt by Edison to make use of carbon. Sawyer and Mann took out two United States patents, and at least one British patent, covering their invention of hydrocarbon treatment. The British patent, known as the "Cheesbrough," of November 28, 1878, was fully sustained by the highest courts of that country, after protracted litigation, its principal claim being for the "method of preparing the illuminating portion of an electric lamp, consisting of electricity heating the same while it is surrounded by a carbon gas or liquid." The first domestic patent (No. 211,262), dated January 7, 1879, was similar to the British patent, except that the process claimed was, for some unexplained reason, limited to immersion in hydrocarbon "liquid." After the issue of this patent the United States Electric Lighting Company filed a conflicting application, claiming priority of invention in behalf of Edward Weston, making substantially the same claim as that of the above-mentioned British patent, and ultimately succeeded in securing the patent which has now been pronounced invalid by Judge Acheson.

The present adjudication is, therefore, in effect an affirmation of the validity of the Sawyer and Mann patent. Moreover, on November 29, 1878, Sawyer and Mann obtained a second patent, covering an electric burner of carbon "consolidated and purified by electrical treatment in combination with a carbonaceous substance," which, of course, embraces treatment by gaseous as well as liquid hydrocarbons. But it will be noted that both of these patents were issued, and one of them was applied for, subsequent to the date of the British patent for the same invention, which circumstance still further complicates the legal situation. Both of these Sawyer and Mann patents, as well as the discredited Weston patents, are now controlled by the Westinghouse Company, a fact which is the more interesting to lamp manufacturers, inasmuch as nearly all the incandescent lamps now made contain carbons which have been treated by the hydrocarbon process. Another point of interest in connection with Judge Acheson's decision is, that the finding is directly contrary to that of the late Judge Bradley in the McKeesport fibrous carbon case, who, upon precisely the same evidences of fact, held that the work of Sawyer and Mann was not a "practical and public use," and hence did not anticipate Edison's subsequent discoveries. In short, it looks very much as if the prospect of a final settlement of the legal status of the incandescent lamp, in view of this decision, was farther off than ever.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE following is the report submitted by the Directors of the Baltimore Consolidated Gas Company to the shareholders at the recent annual meetlng—the figures cover the affairs of the Company up to July 1st:

Assets—		
Cash	$110,759	
Real estate, works and plant	17,420,468	
Gas consumed, not billed	91,937	
Due for introduction	1,213	
Due by tenants	1,033	
Office furniture	500	
Stable account	2,532	
Materials and tools	2,825	
Coal	43,888	
Oil	14,035	
Lime	928	
Reserve account, 5 per cent. bonds	339,000	
Siemens-Lungren lamp account	51,000	
Stock purchase account	168	
Construction account	13,084	
Sinclair, Burns & Hall, trustees	26	
Real estate	15,500	
Total		$18,108,896
Liabilities—		
Capital stock	$10,770,969	
Consolidated bonds, 6's	3,584,500	
Chesapeake " "	1,000,000	
Equitable " "	920,000	
Consolidated " 5's	1,191,000	
Coupons	155,490	
Deposit account	30,547	
Taxes	20,546	
Sundry bills	31,775	
Pay roll	608	
Net surplus, July 1, 1892	403,461	
Total		$18,108,896
Net earnings for year ended June 30	834,097	
Fixed charges, interest on funded debt	373,150	
Surplus revenue		$460,947

The Company paid a semi-annual dividend of 1½ per cent. in December, 1891, and 2½ per cent. in June last, making 3¾ per cent. for the year. The gross earnings increased about $109,000 over the preceding year, and the output increased about 5 per cent. Under the charter of the Equitable Company, $15,000 Equitable 6's are purchased and retired each year.

SUPERINTENDENT W. A. ARMINGTON, of the Flatbush (L.I.) Gas Company, has about completed the betterments planned for that plant last spring.

It is reported that the National Gas Light and Fuel Company, of Chicago, will construct a gas works at Great Falls, Montana.

At the annual meeting of the Fall River (Mass.) Gas Company the following officers were chosen: Clerk and Manager, George P. Brown, Fall River; Treasurer, Edward C. Lee, Philadelphia; Directors, John S. Brayton and George P. Brown, of Fall River; Elihu Andrews, of Swansea; Samuel T. Bodine, Randall Morgan and Henry Levis, of Philadelphia; and David Paton, of New York.

We are indebted to "H. J. A." for the following interesting particulars concerning the Yonkers (N. Y.) Gas Light Company: "Of the many manufacturing enterprises in Yonkers, that of the Yonkers Gas Light Company is one of the most important, and illustrates the enterprise and business capacity of many of the citizens of that beautifully situated suburb of New York city. The Company was organized in 1854, by Col. W. W. Scrugham, who was foremost in inaugurating the enterprise, with S. S. Botten, Timothy C. Dwight, Robert P. Getty, T. C. Cornell, Robert Grant, James Scrymser, Josiah Rich, F. S. Mills and William Warburton as Directors. The incorporators were the same men, with the addition of Joseph Olmstead and H. F. Devoe. The first President was Joseph Scrymser, and the first Secretary and Treasurer was Col. Scrugham. The works were completed and gas was delivered in 1854. The plant was located on Woodworth avenue, which is still a part of the site, just above Ashburton avenue, and a capital stock of $100,000 was soon subscribed, which sum has been since increased from time to time. From the beginning the Company was successful financially, and was liberally patronized by the city authorities. The sales have amounted to as much as 30 million cubic feet per year, and the illuminating power is 25 candles, increased from 12 candles in 1860. The introduction of this industry was, of course, a material factor in the advancement of the interest and city conveniences of Yonkers. Not till 1861, however, were street lights put in operation, and they were first introduced on Warburton avenue. They were then left burning until midnight, except when there was a moon, when they were not lighted at all. From this, the gas street lighting of Yonkers has been increased, notwithstanding the introduction of electric lighting. The Company now makes water gas; up to 1879 coal gas was made. The price, which was $3.50 in 1861, and $4.50 in 1870, per 1,000 cubic feet, is now only $1.25 per 1,000—a state of affairs largely brought about by improvements in manufacture and economies in distribution. The principal figure in the history of the Company has been Mr. Thomas C. Cornell, its President at this time, who was born in Westchester county, in 1819. Perhaps some of the facts connected with his long and active career may be of interest. The aggregate of his schooling, which did not exceed three years, was ended before he was 12 years old. Whatever he learned thereafter was in the hours saved from daily labor. At 15 he was doing a man's work on the farm, keeping up his studies at early morning and late at night. His father became surveyor of the neighborhood, and in 1830 removed to Rochester, as surveyor and civil engineer, and Thomas was his principal assistant. After coming of age (1840) he entered the engineering department of the State, in the Erie canal enlargement, and had charge of the work on the combined locks at Lockport. In 1844-6 he was in the employ of the Canadian government, at Montreal, on the Lachine canal, and in the office of the engineer of the Provincial Board of Public Works. He returned to America in the latter part of 1847, and was immediately employed in the construction of the Hudson River Railroad, on the section from Spuyten Duyvil Creek to Dobbs Ferry. This brought him to the then small hamlet of Yonkers, where, when his section of the road was finished, he decided to remain. He did almost all the surveying and engineering of Yonkers for many years, with occasional work as architect. In 1854 he co-operated with Messrs. Scrugham, Getty and others, as remarked before, in founding the Yonkers Gas Light Company, which first delivered gas in November of that year. He has been President of the Company since 1857, and also its Treasurer since 1860. He is also interested in many of the other business and financial enterprises and institutions of Yonkers."

It is understood that those most interested in the Proposed Gas Company for Cookston, Minn., are Alexander McHinnon and Hugh Thompson, of Grand Forks, N. D.

The Seneca Falls and Waterloo (N. Y.) Gas Light Company at its last election made many changes in its executive management. The officers are as follows: Directors, Archibald Parkhurst, of Newark, N. J.; William B. Sands, of New York; Edward Miller, of Philadelphia; Pryce W. Bailey and Fred. Maier, Jr., of Seneca Falls; President, Fred. Maier, Jr.; Secretary, Treasurer and Superintendent, Robt. J. Dobson.

The proprietors of the Salem (Mass.) Gas Light Company have reduced the selling rate to $1.60 per 1,000. The average price received by the Company for gas sold during the 12 months ended June 30, 1891, was $1.76 per 1,000.

The residents complain that the Haverhill (Mass.) Gas Company is maintaining a nuisance in permitting the refuse from its plant to flow into the Little river.

The following explains itself: "The Directors of the Derby Gas Company have learned with sorrow of the death of one of their number, Charles E. Bristol, of Ansonia, and to show fitting respect to his memory, this minute and resolution were unanimously adopted. Mr. Bristol had but recently been elected a Director, and had never met with the Board, but to the most of the members he was a life-long associate and friend, and we had looked forward with agreeable anticipation to his attendance at the meetings. In his death this Board recognizes that it has lost an able and genial member, one who by his good business judgment would have aided materially in its deliberations, and who by his very pleasant address and many gentlemanly qualities would have added pleasure to its meetings; therefore,

"*Resolved*, That we tender to his family our sincere sympathy in their great loss, that a copy of the foregoing be sent them, and that the same be inscribed on the record book of the Company.

"The above resolutions were passed at a meeting of the Directors of the Derby Gas Company, held on July 18, 1892.—Chas. H. Nettleton, Clerk."

The Vulcan Gas Company, of Chicago, has been incorporated by H. S. Gillette, J. R. D. Graham, B. L. Gorich and others. It is the purpose of the Company to manufacture gas under the W. H. Taylor system. The inventor, whose headquarters are No. 1304 Chamber of Commerce Building, Chicago, talks of little else than the millions that are in his process; but the trouble is to get them (the millions) out of it.

The works of the Cicero (Ills.) Gas Company will be located on a plot of land on Lombard avenue, south of the Wisconsin Central Railroad. The Company is under bond to furnish gas by May 1, 1893.

The public lighting committee of Fort Madison, Ia., advertise for proposals for lighting the city, for 3 or 5 years, the competition to close on the evening of August 15th. Bidders are asked to figure on supply-100 arcs, of 1,200 or 2,000 candle power; also on 200 to 300 gas lights, and on a mixed system of arc lights (50) and gas lamps (150), all proposals to be based on all night and every night lighting table.

At the annual meeting of the Norwalk (Conn.) Gas Light Company the following Directors were elected: E. K. Lockwood, E. J. Hill, Ebenezer Hill, P. L. Cunningham, W. F. Bishop, T. S. Morrison, J. H. Ferris, J. A. Osborn and R. H. Rowan.

The Van Syckle Gas Light and Fuel Company has been incorporated at Upper Sandusky, O.

The Waterbury (Conn.) Gas Company's mains have been extended 1,500 feet on Baldwin street, 1,000 feet on North Main street and 200 feet on Vine street. Nothing smaller than 4-inch was used. Much of the trenching had to be carried through a very refractory bed of rock.

The foreclosure proceedings in the case of the bondholders vs. the lessees of the Fishkill and Matteawan (N.Y.) Gas Company were terminated, on July 25th, by the sale at public auction of the plant, franchises, etc. The property was bought in by a committee of the bondholders—Messrs. Scofield, Strong and Havens—who offered $5,000. The bonded indebtedness of the Company is $20,000. Mr. William Scofield is now in charge of the plant as Superintendent.

The Arlington (Mass.) Gas Light Company has reduced its selling rate to $2.50 per 1,000 cubic feet—a concession of 25 cents per 1,000.

If further proof were needed that the incandescent electric lamp is not what its candle rating purports to be, we imagine that the results of the tests made in July last, by Professor B. F. Thomas and two assistants, at the State University, Columbus, O., would be ample. 110 volt carbon filament lamps were used in the trials, and the results showed that the mean horizontal candle power of the lamps was only 14.5 candles when new, instead of 16 candles as claimed by the label of the man-

ufacturers. The candle power diminished with fair uniformity, or at rate of 10 per cent. for each 200 hours burned. The initial average efficiency employed was 4.2 watts per candle light; at 600 hours it was 5.9 watts; and at 1,200 hours (for the few lamps that lasted that time) it was 7 watts. Thus, at the end of 600 hours, the lamps would give only 40 per cent. of the initial light, or only 7.5 lamps per electrical horse power. The lamps at starting averaged 4.2 watts and 14.5 candles, instead of 16, which is only 170.7 candles per electrical horse power; and at the end of 600 hours they gave only 120.6 candles, which would be but 7.5 lamps of 16 candles to the electrical horse power. The lamps that were tested included good specimens of the Edison, Thomson-Houston, Sawyer-Mann, Economic, Beacon, Columbia, Perkins and 5 or 6 others. The best lamp tested gave only 190.6 candles to the electrical horse power at starting, which would be 3.8 watts per candle, and only 11.8 lamps of 16 candles to the electrical horse power, and at the end of 600 hours the average was only 7.5 lamps to the horse power. The Columbus tests were carried out on an impartial basis and with great thoroughness, and as the lamps were purchased in the open market, without any suspicion on the part of the sellers as to what use they were to be put, it goes without saying that the bulbs were fair types of those in commercial use. The results certainly prove that no maker of carbon-filament lamps can truthfully claim to supply a grade of lamp equal to maintaining 12 of such, of 16 candles each, to the electrical horse power. In fact, further, if in these tests the current had been increased so as to keep the lamps up to 16-candle power, constaut, there is no doubt that the lamps would all have given out before the end of 300 hours, because at that time the current would have had to be increased to 176 volts.

THE Rochester (N. Y.) Gas Company has transferred plots of ground, located on Mumford street and St. Paul and River streets, respectively, to the Rochester Land Company.

THE annual meeting of the Greenfield (Mass.) Gas Light Company was held a few days ago. A dividend of 3 per cent. on the preferred stock and 1½ per cent. on the common stock was declared, after which the following officers were chosen: Directors, F. R. Allen, W. N. Washburn, F. A. Pond, W. A. Forbes and J. D. Safford; President, F. R. Allen; Clerk and Treasurer, Dana Malone.

AT the annual meeting of the Woburn (Mass.) Gas Light Company, it was virtually determined to extend the mains in several directions—notably through Cleveland avenue, from New Boston to Beach streets. The following officers were elected: Directors, B. Hinckley, Jno. Johnson, G. R. Gage, C. A. Jones, R. J. Monks; President, B. Hinckley; Secretary and Treasurer, R. J. Monks.

THE Directors of the Bay State Gas Company, Boston, Mass., have declared a dividend of 1 per cent. on the capital stock, which is payable on and after Sept. 1st.

THE Buffalo (N. Y.) Brush and Thomson Houston Arc and the Edison Incandescent Electric Companies have consolidated their interests under the title of the Buffalo General Electric Company. It is likely that Mr. Daniel O'Day will be chosen President, and that Mr. Charles R. Huntley will be appointed General Manager. The capital stock of the General Company will be $1,800,000—a pretty good load.

WE are indebted to "One Who Was There" for the following account of the doings at Pawtucket, R. I., on the afternoon of July 30th, on the occasion of the Stiness reception at the new station of the Pawtucket Company: "To-day occurred the formal opening of the elegant new station of the Pawtucket Gas Company, on Tidewater street, and Superintendent Stiness entertained more than a score of Managers of New England gas and electric light plants. Among those present were H. B. Leach, President of the Guild of Gas Managers; Colonel Jas. H. Armington; William Anderson, Superintendent East Boston Gas Company; Chas. S. Waldo, Boston; C. M. Coburn, Chelsea, Mass.; F. W. Thomas, Boston; R. F. Ross, Boston; Geo. B. Neal, General Manager, and P. Coyle, Superintendent of the Charlestown Gas and Electric Light Company; F. M. Gilley, Boston, Mass.; E. A. Chapel, Superintendent Chelsea Gas and Electric Light Company; H. A. Atwood, of the Plymouth (Mass.) Gas and Electric Company; F. C. Sherman, Superintendent New Haven (Conn.) Gas Company; George L. Sadler, Nashua, N. H.; A. K. Quinn, Treasurer, Newport (R. I.) Gas Company; J. K. Montgomery, Chelsea, Mass.; C. F. Spaulding, Superintendent Waltham (Mass.) Gas and Electric Company; C. J. R. Humphreys, General Manager Lawrence (Mass.) Gas and Electric Company; J. A. Coffin, Superintendent Gloucester (Mass.) Gas Company; A. B. Slater, Treasurer Providence (R. I.) Gas Company; S. J. Fowler, General Manager Springfield (Mass.) Gas and Electric Company; John Post, Boston; Charles F. Prichard, Secretary New England Association of Gas Engineers; George H. Remington, Providence, R. I.; and Z. M. Jenks, General Manager Woonsocket (R. I.) Gas and Electric Company. Besides the out of town visitors there were present the following prominent Pawtucket people: General Olney Arnold, George L. Walker, Jas. G. Fales, E. A. Perrin and Honorable A. H. Littlefield, all Directors of the Pawtucket Gas and Electric Company; General Manager Luther, of the Pawtucket Street Railway; Sanford Pierce, Claude Farnsworth, Charles H. Bullock, Bela P. Clapp, N. B. Dennison, Fred. Taylor and representatives of the press. After carefully inspecting the entire plant, and particularly the new station, which is equipped with every modern electric appliance, President Leach, of the Guild of Gas Managers, was introduced by Superintendent Stiness, who stated that the Guild was organized to disseminate any and all facts that could be gathered respecting progress in the manufacture and distribution of gas or electricity. Its foundation stone was that one member should give to another any information that he could impart. He believed that the Guild had done very much during its existence towards improving the gas works of New England. Ex-Governor Littlefield was then introduced, and in behalf of the Board of Directors extended all a hearty welcome, not only on the account of the Gas Company, but on the part of the city as well. He complimented Superintendent Stiness and the members of the Building Committee on the excellence and completeness of the new station, and hoped that the guests would, when starting for their homes, feel that they had spent a very pleasant day in Pawtucket. Mr. Ross then made a graceful speech, after which came an invitation to partake of an elaborate spread, which was relished by all. At 1:15 P.M. one of the Pawtucket steamers steamed up to the Company's wharf and Superintendent Stiness and his guests embarked for Crescent Park, where they all enjoyed themselves under his especial care."

FRANK S. RICHARDSON is amusing himself these days by remodeling and extending the main system of the North Adams (Mass.) Gas Company. He is doing it thoroughly, too.

A Theory of Illumination.

"L. T. M.," in the *Scientific Press*, asserts that the development of the theory of light has made considerable progress of late years and its true nature correctly defined; but, according to my views of the subject, scientists are still somewhat off the track as regards certain minor points, such as the illumination of opaque bodies. A beautiful analogy exists between the phenomena of sound and light. It is universally understood that both are results of the same great force—motion. Motion in the atmosphere and motion in that mysterious fluid, ether, appeals to our senses, the former to our ears, the latter to our eyes, producing the effects we call sound and light.

Now, ether is that subtle fluid filling all space, permeating all matter, the media of light-waves whereby light and heat are transmitted from the sun to our earth. There is an intense agitation and commotion of particles continually going on in the sun, and these impulses transmitted to the surrounding ether are carried on and out in ever lengthening lines until some of them strike our interfering atmosphere and we have the phenomenon of light.

Darkness, you say, is due to the absence of light, and light, we have just seen is atomic vibration; hence, darkness must be comparative passivity. Go to your room at night when all is dark and you see nothing whatever, for the composing atoms of each object in that room are in comparative rest. But now light the gas; immediately vibration is set a going by the combustion, and passing on it agitates the atoms of every object present. You now look at matter made visible not by reflected rays, as commonly supposed, but by light-waves of their own creation, caused by the imparted energy. A luminous body is the source of etheric light-waves, while an opaque substance is made visible by the presence of a luminous one.

Light is as much more subtle than sound as ether is than air, and the general truths of the one apply to the other, and vice versa; hence, in tracing the analogy we discover a beautiful correspondence between sympathetic *sound* vibration and light illumination, which we at once see is nothing more than sympathetic *light* vibration. The rays of the sun reach the side of the moon visible to us, creating among the atoms of that body a violent agitation. When they strike, their office is fulfilled; their motion has been checked, and they cease to be. But now the commotion of the moon's particles imparts its energy to the surrounding ether and thence to us, giving us the delightful evenings of full moon. Give credit where credit is due, give the honors to the moon and stop heaping them upon her big brother, the sun. She vibrates in sympathy with his vibration, the analogy here being perfect—stop the source of the sound and there would be no sympathetic vibration from a neighboring instrument; refuse the moon the presence of the sun, and she would ever remain invisible.

In the particles of most matter composing opaque bodies sympathetic vibration ceases the moment the luminous one is removed, the atoms returning to their original comparative passivity. Some substances, however, are exceptions, such as the sulphides of calcium, strontium, etc., which retain, for a short time, the imparted energy. It is to these substances we attach the name phosphorescent.

This somewhat meager outline of light propagation may be profitably extended in all the various phenomena of light with interesting results. We are not yet at the end of the tether of discovery; many startling facts await our persevering efforts.

The Market for Gas Securities.

The city gas share market showed unwonted animation for midsummer, the inquiry for Consolidated having been sufficient to send the price up up to 117, which figure was bid for it at the opening to day (Friday). On Thursday the unusually large number of 3,415 shares changed hands in the day's trading, and holders were predicting 125 for it before next dividend day. Standard was also inquired after, especially as to the common, which was bid for at 83½. In Brooklyn all classes of shares were firmly held, Nassau holding the lead at 142 bid. Brooklyn gas is offered at 138, although we believe that inquiry for a round lot would send the rate to 145. The Brooklyn situation shows no change in respect of the attitude towards one another of the several Companies, but it will be different there before the snow flies. The Bay State Company has declared a dividend of 1 per cent., but no appreciable effect was thereby exerted on the stock. Baltimore Consolidated is bid for at 60½, and Laclede rallied to 23½. Chicago gas is steady.

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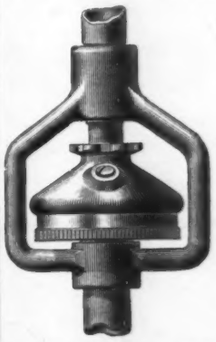

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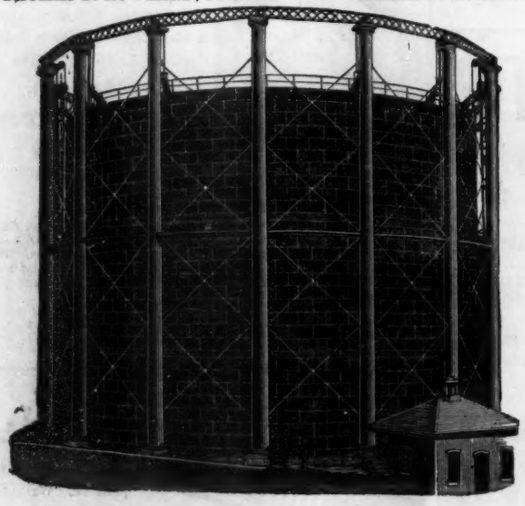

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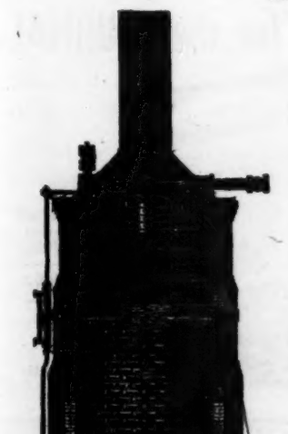

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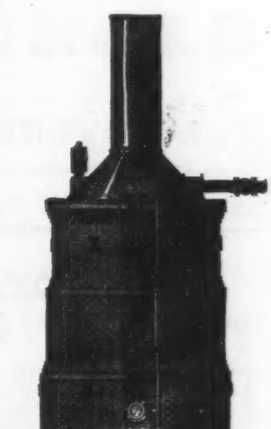

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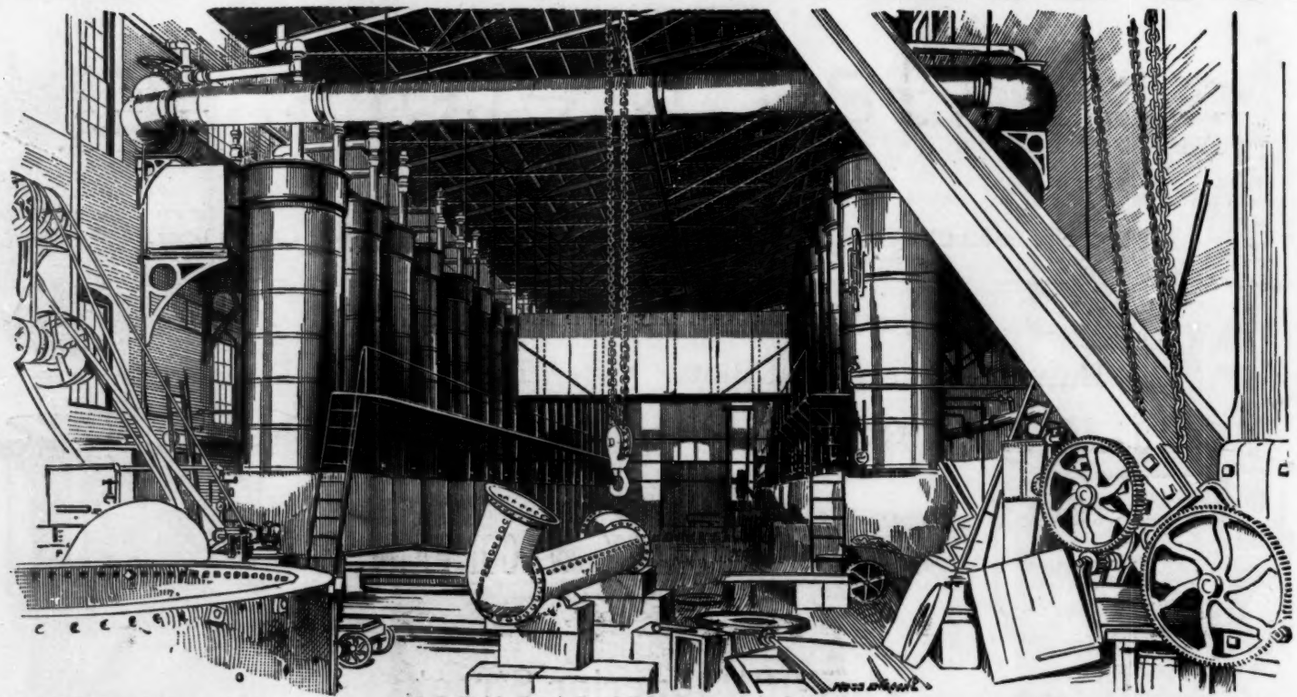

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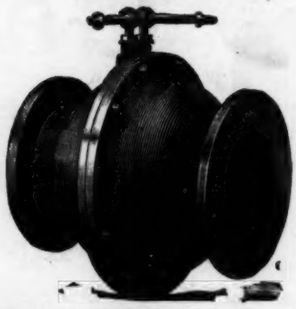

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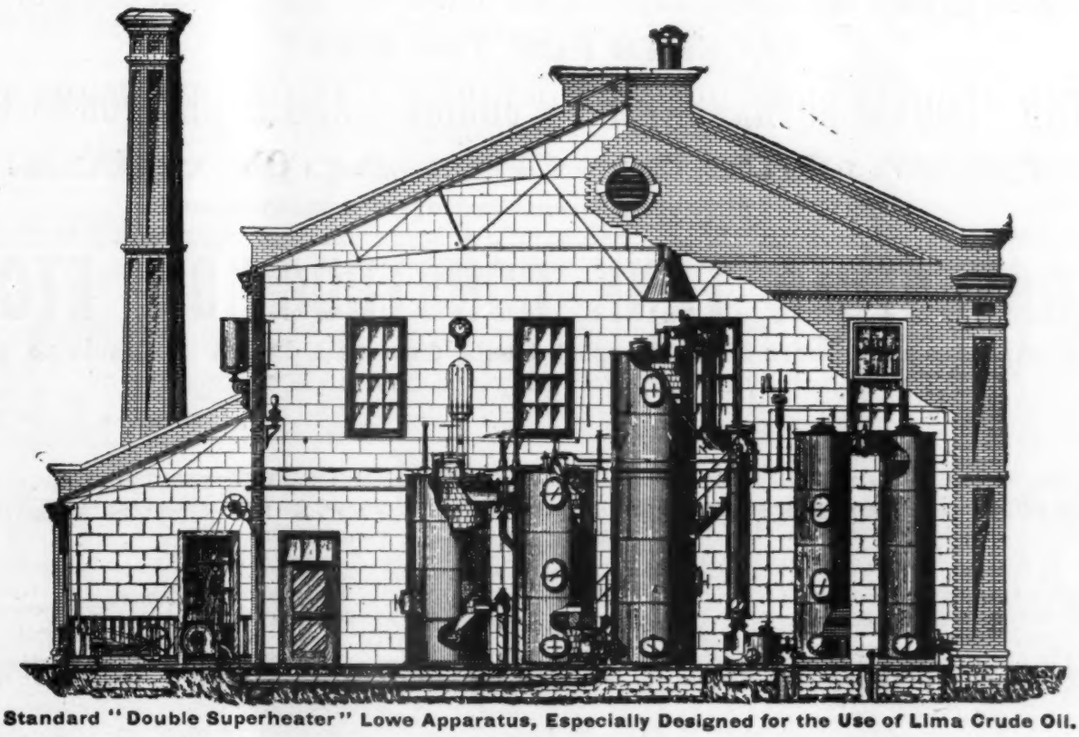

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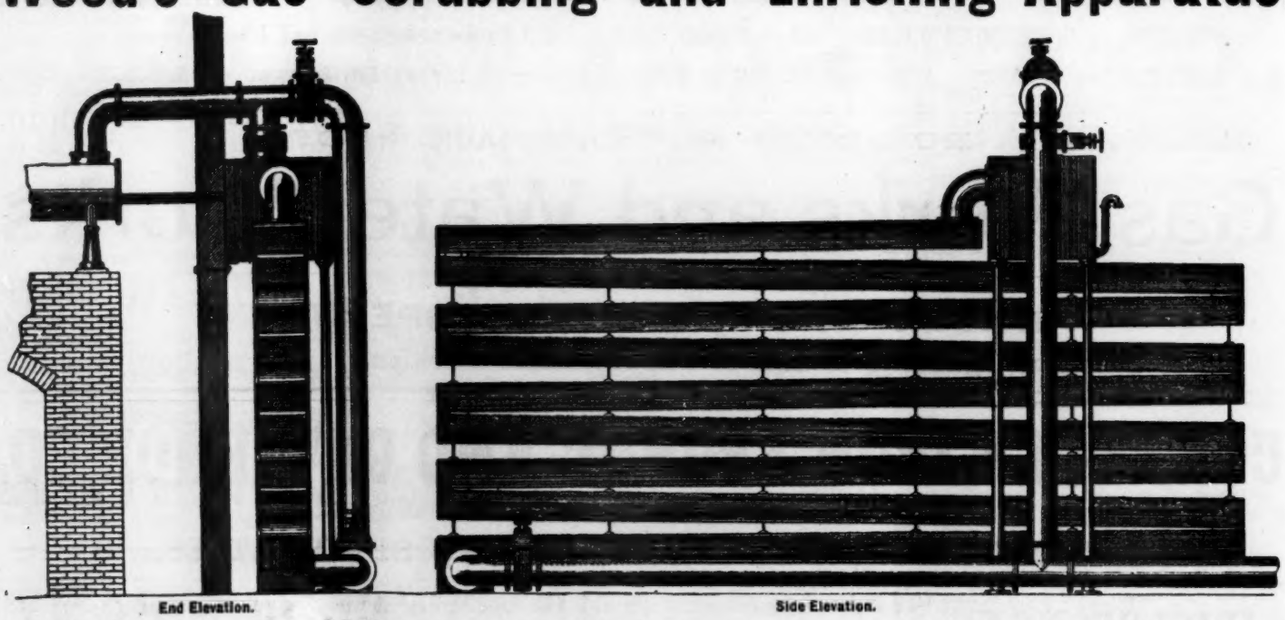

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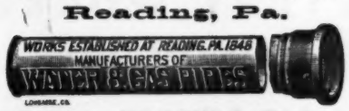

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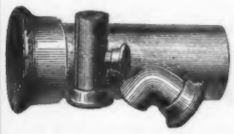

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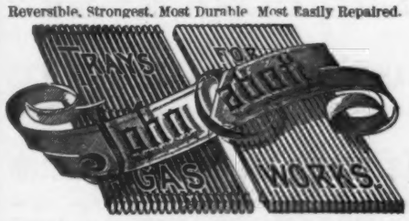

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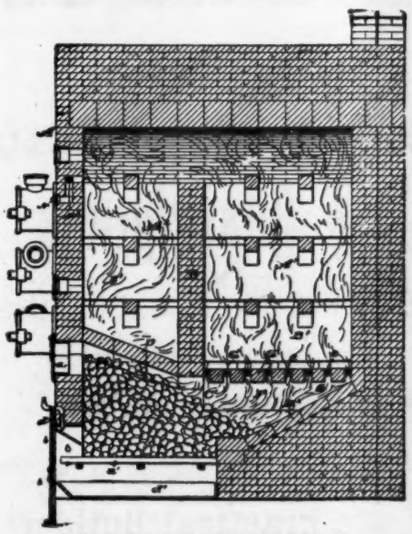

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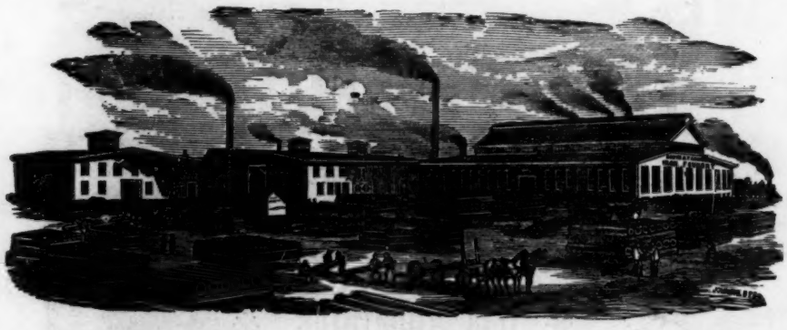

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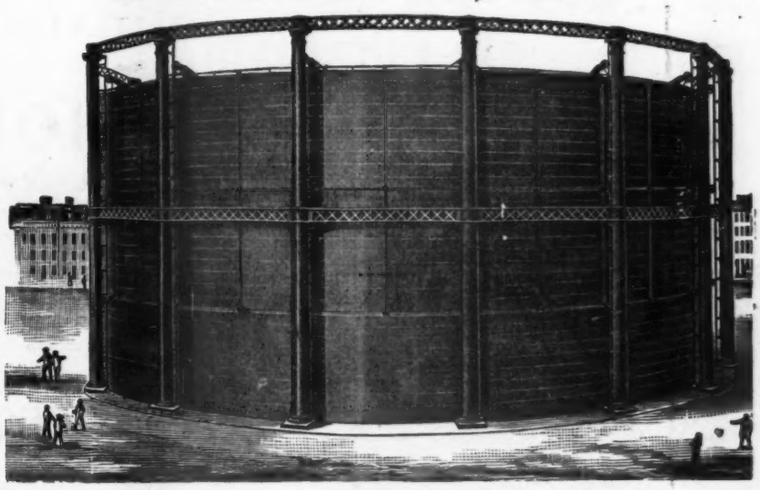

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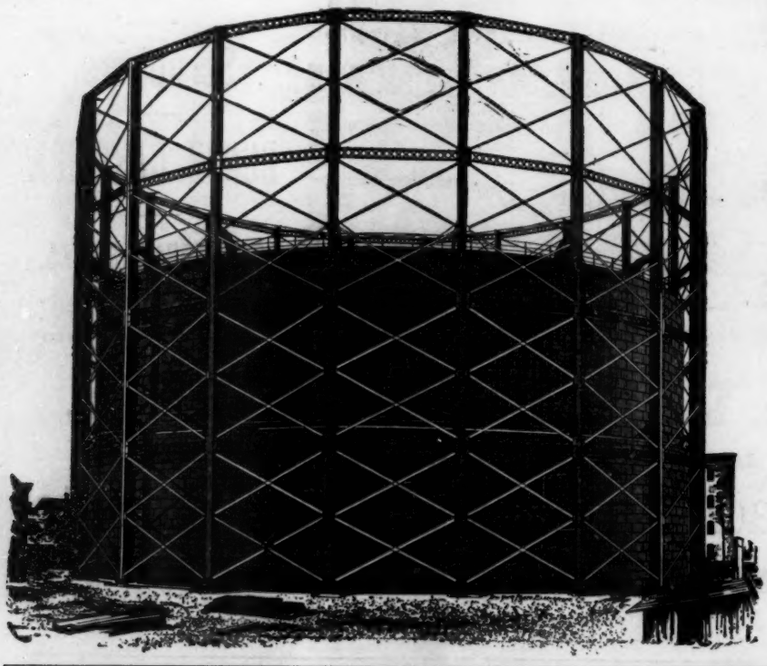

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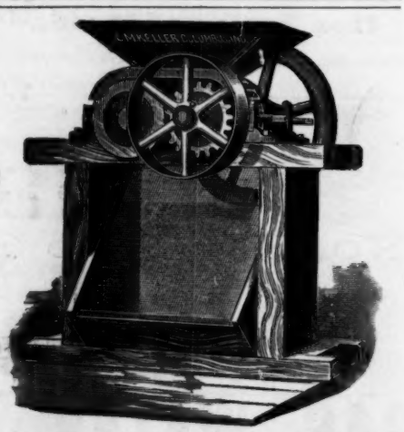

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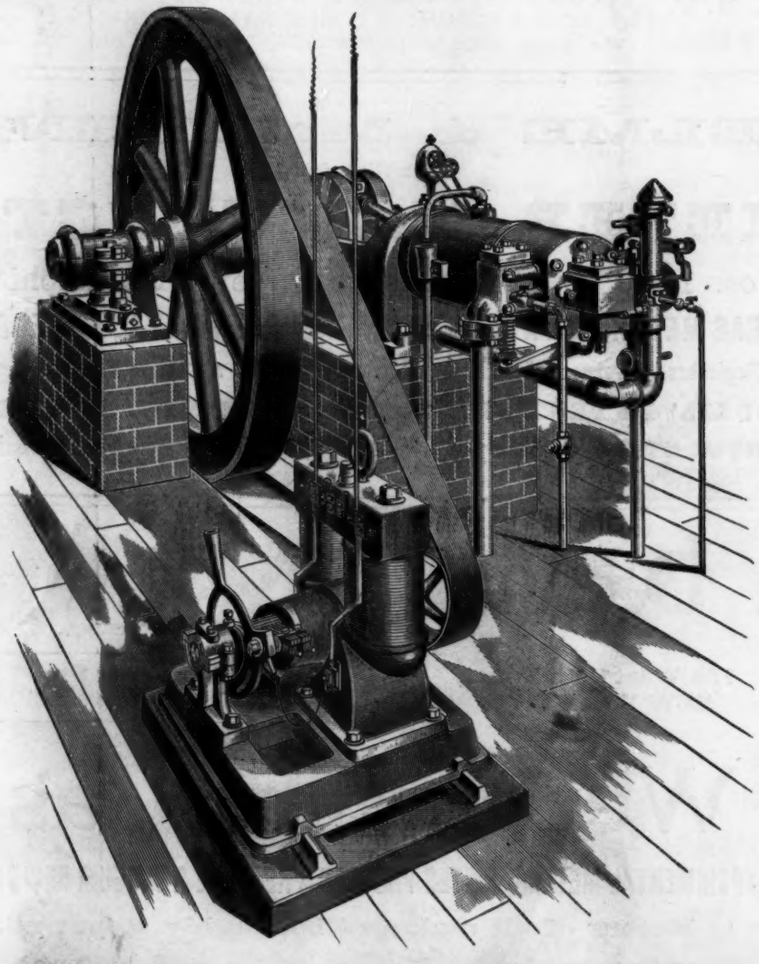

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